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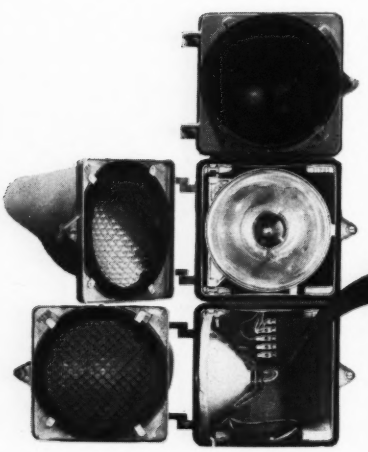

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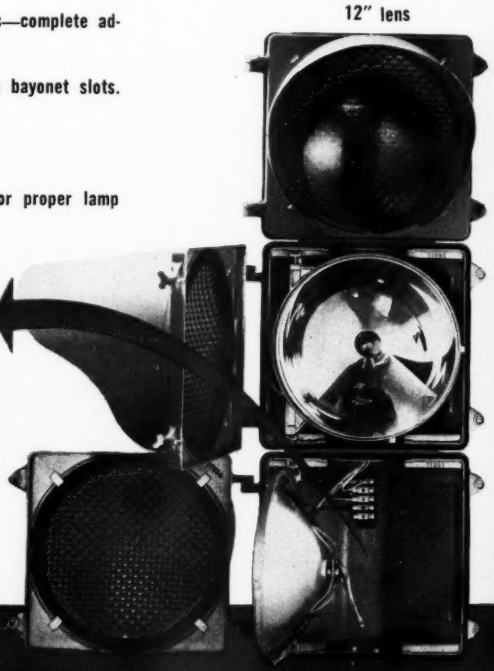

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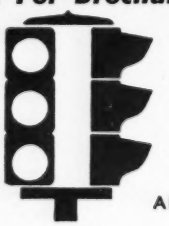

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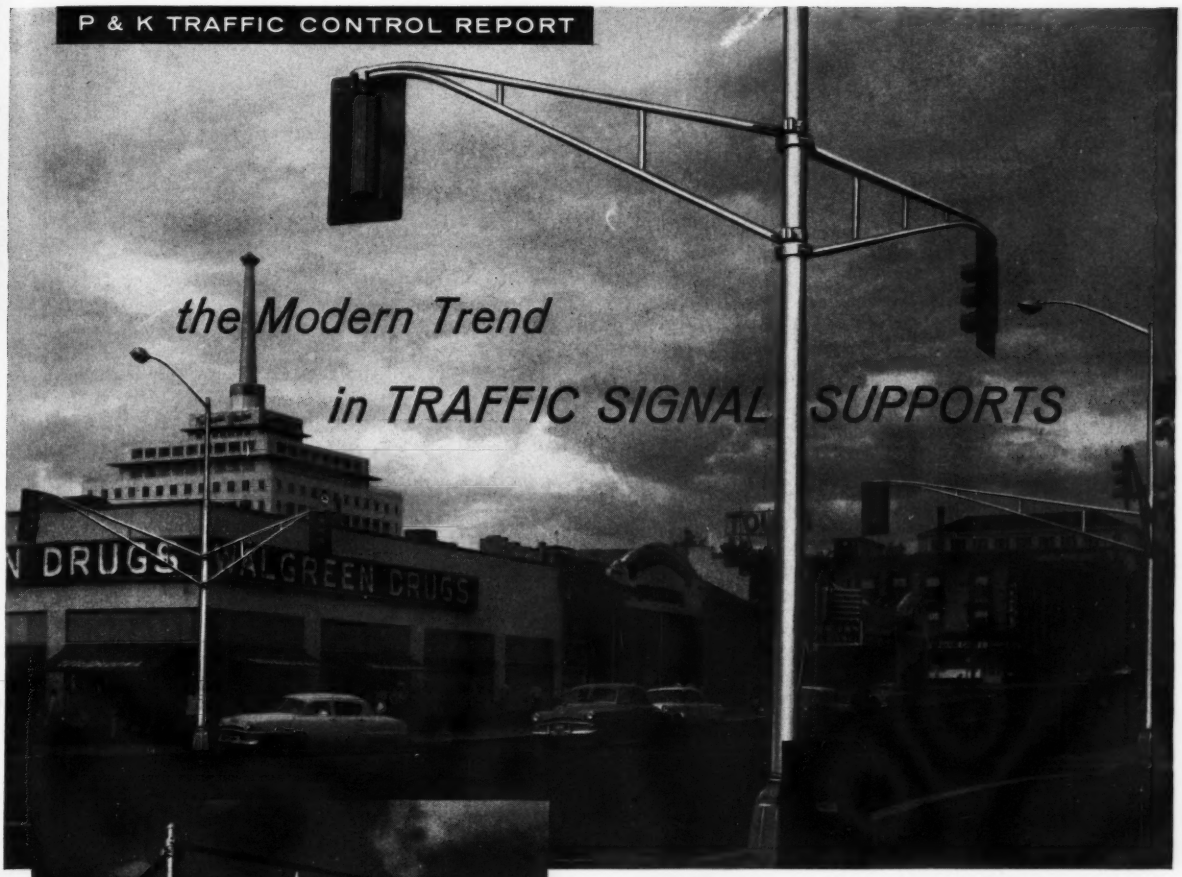

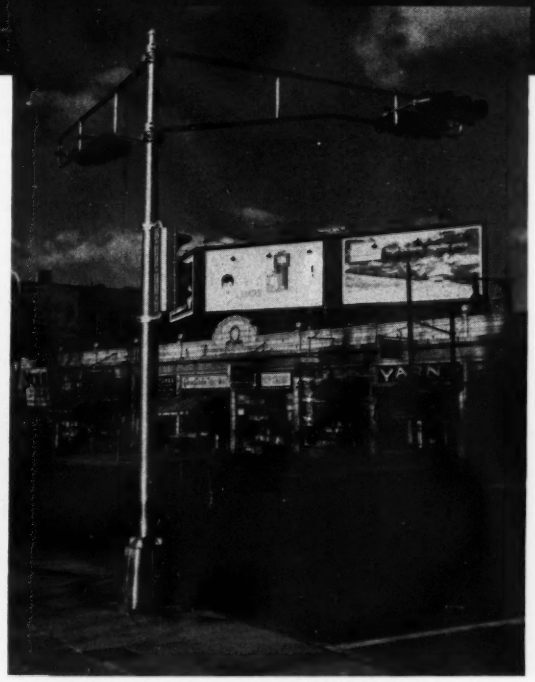

TOP PHOTO: Denver, Colo.; Combination lighting & traffic signal mast arm standards.

BOTTOM PHOTO: Orange, N. J.; Twin trombone arm traffic type standard.

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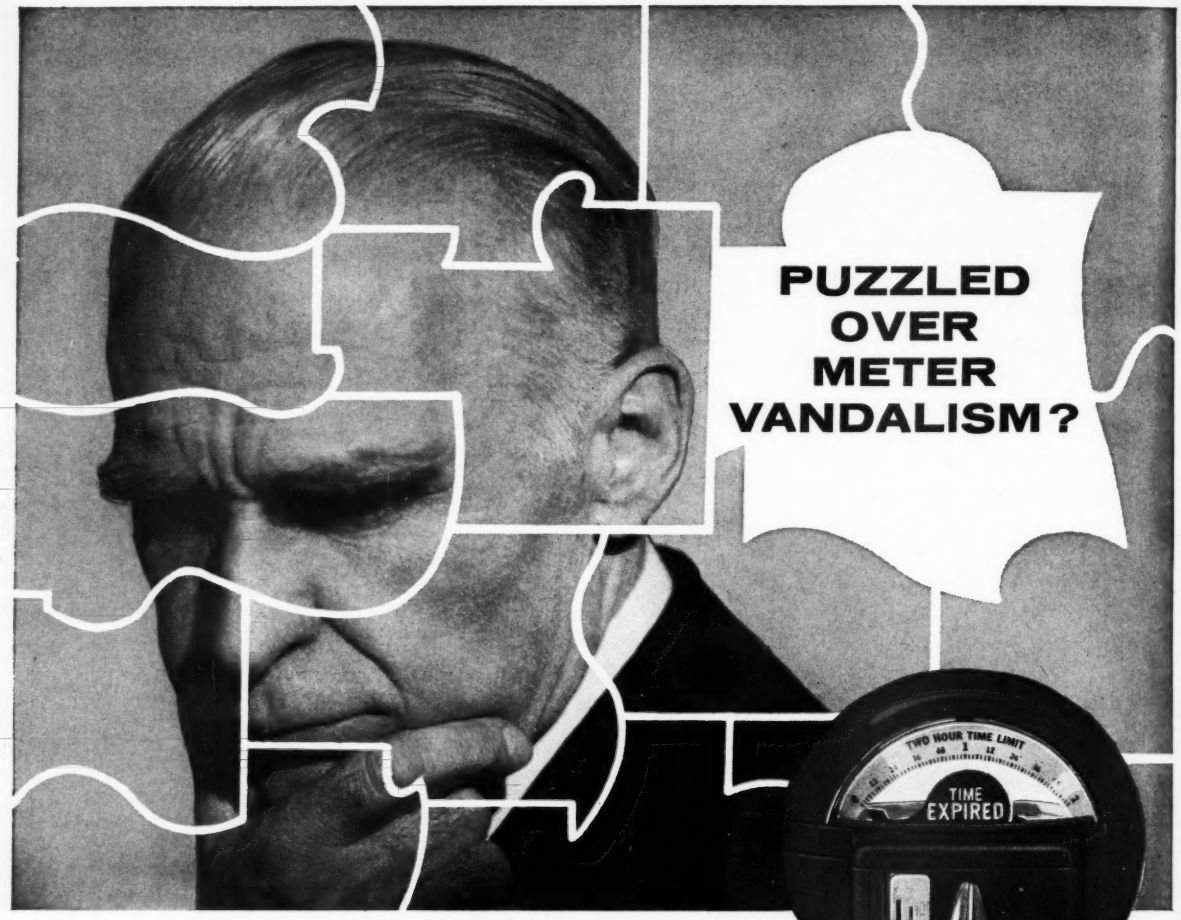

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COVER: SPRING — WAY BACK WHEN! How many readers remember when this was a common sight — and even experience? A far cry from the Interstate Highway System — or even the ordinary road today. —Photo courtesy of Texas Highway Department (**although the scene is probably not Texas**).

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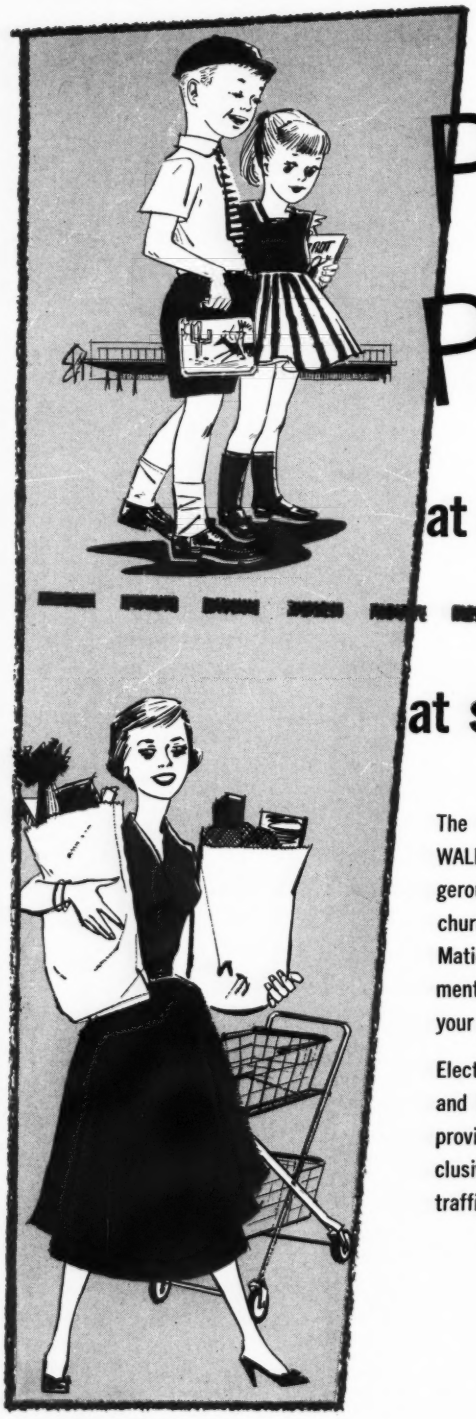

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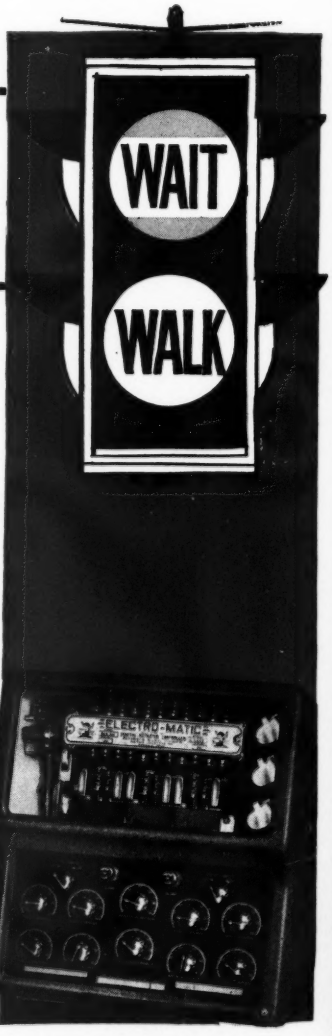

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The scientific knowledge of traffic engineering is improved and increased by a judicious combination of theory, experimentation and experience. Unfortunately, basic research, from which much of the theory may be developed, is too often beyond the facilities and responsibilities of the practicing traffic engineer who must devote all of his time to adequately administer to the pressing daily traffic problems within his jurisdiction. Often, he has little time, after attending to administrative and technical problems, to undertake the types of research which frequently have no direct application to his work. Unlike industry, few city and state traffic engineering departments have sufficient budget or personnel to undertake basic research. These departments are not in competition with each other and the incentive to conduct research is deferred to those organizations and agencies responsible for the establishment of underlying principles and over-all economies. When practicing traffic engineers in cities and states are unable to undertake basic research projects themselves, they can make substantial contributions by supporting the research efforts of others; and by giving them advice derived from the insight they have gained through experience.

The state and city traffic engineer has a direct responsibility to contribute toward traffic research in the area of experimentation. No other is better qualified or in a better position to do this. Adequate "before and after" studies are an important part of the daily work of the state and city traffic engineer. Needless to say, these measurements are needed to "sell" the improvement and to provide facts for ultimate solutions of specific traffic problems. Experiences based on facts obtained through experimentation are a vitally important part of the research process. Members of the Institute who gather these facts and report them through the Institute's technical channels are meeting their responsibility to help increase the scientific knowledge of the traffic engineering profession.

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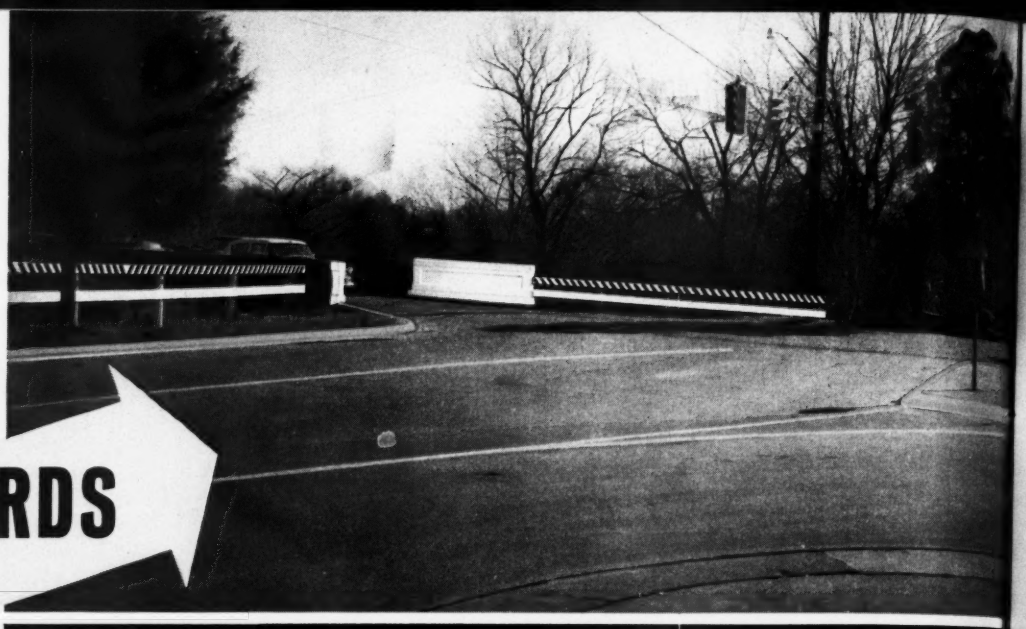

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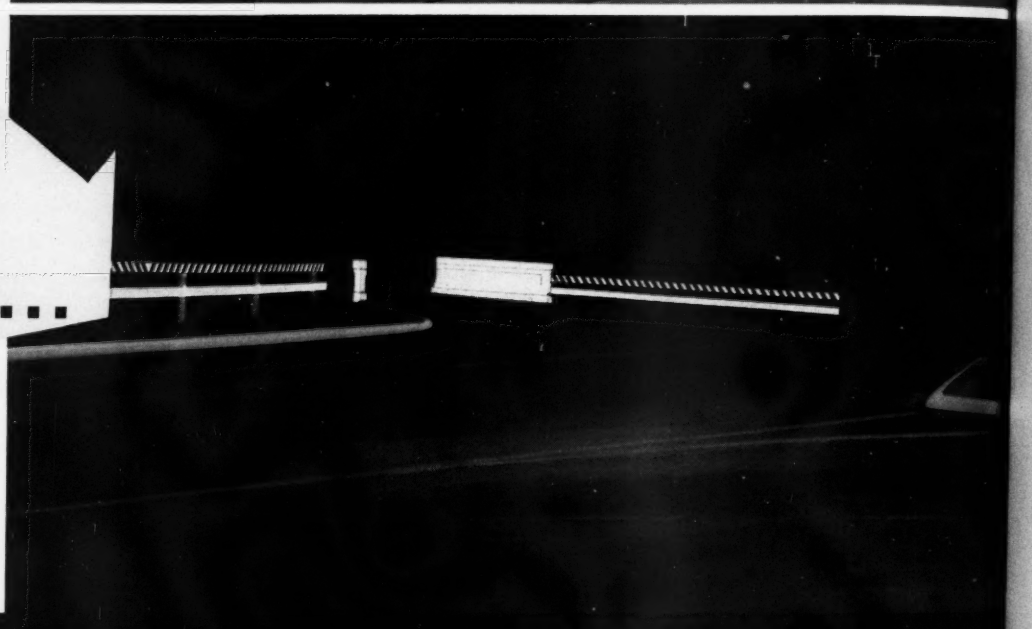

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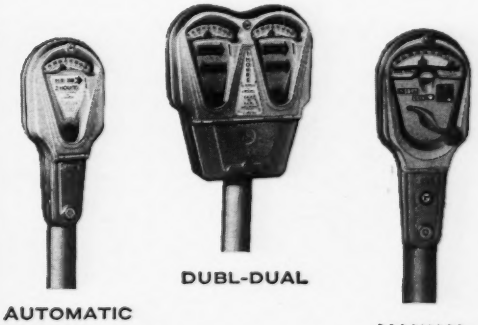

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Theoretical Traffic Volume and Timing Studies

By George Sagi, E.E.,
Signals Department, City of Winnipeg
Manitoba, Canada

THIS STUDY is basically theoretical as the title indicates. The first section develops further the theory of Levinson's "sluggishness factor," which was derived a few years ago. The other sections, Maximum Theoretical Capacity, Practical Maximum Capacity, Calculation of Minimum Green Time and the graph of Volume versus Cycle Length, are believed to be original. Furthermore the study shows the need of a short-interval counting method, called Minute Volume Counting.

1. Effect of One Stop on the Free Flow of Traffic

The conditions under which we wish to discuss traffic flow are the following:

a) Single lane without intersections
b) One-way movement
c) Constant speed
d) Homogeneous spacing of vehicles

Generally we would say these are theoretically ideal conditions.

On this lane let one vehicle stop for any reason at the $\overline{AA}$ line for a certain duration of time (T_{stop}) and then let it proceed. Our purpose is to examine the effect of queueing on the following vehicles. It is easy to show this effect graphically, as it is done in Figure 1.

The number of vehicles arriving in the first group and forced to stop during the time T_{stop} is:

$$N_1 = T_{stop} \frac{V}{3600} \quad \ldots\ldots\ldots\ldots 1)$$

where

N_1 = the number of vehicles in the first group.

V = the volume of vehicles approaching $\overline{AA}$ per hour.

T_{stop} = the duration of stop time in seconds, shown in Figure 1.

The direct effect of the stop time is to cause stop of N_1 vehicles.

However, when T_{stop} has passed, only the first vehicle can start after a certain time which involves different factors, e.g. perception-reaction time, vehicle response, road surface conditions, slopes etc. It is not the object of this paper to study these factors.

Let us call the average time between the start of successive vehicles T_{start} (see Figure 1), then the time needed to start for N_1 vehicles is:

$$T_1 = N_1 \, T_{start} \quad \ldots\ldots\ldots\ldots 2)$$

1 and 2 formulas together,

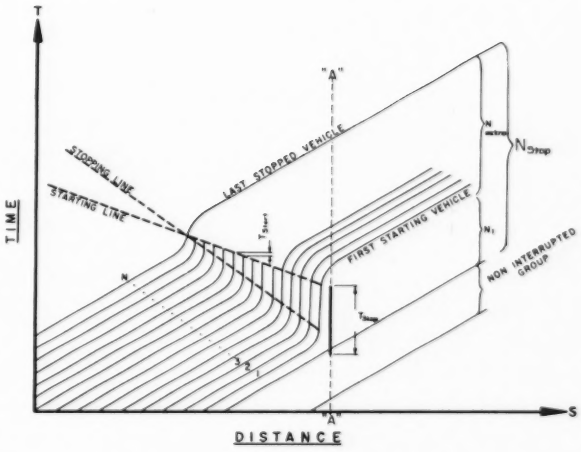


FIG. 1

$$T_1 = T_{stop} \frac{V}{3600} T_{start} \quad \ldots\ldots\ldots\ldots 3)$$

After T_1 time the last of the stopped vehicles in the first group starts. However, during this time other vehicles arrived, because of the continuous flow. These vehicles also have to stop and start again. This process takes T_2 time. However, during T_2 time another group of vehicles arrives, stops, starts, and so on. The whole process can be written as a mathematical series.

The number of vehicles in the first group (as it was shown in equations 1, 2, 3).

$$N_1 = T_{stop} \frac{V}{3600} \quad \ldots\ldots\ldots\ldots 1)$$

Time to Start: $$T_1 = T_{stop} \frac{V}{3600} T_{start} \quad \ldots\ldots\ldots\ldots 3)$$

The second group:

$$N_2 = T_1 \frac{V}{3600} = T_{stop} \left(\frac{V}{3600}\right)^2 T_{start} \ldots\ldots 4)$$

$$T_2 = N_2 \, T_{start} = T_{stop} \left(\frac{V}{3600}\right)^2 T_{start}^2 \ldots\ldots 5)$$

The third group:

$$N_3 = T_2 \frac{V}{3600} = T_{stop} \left(\frac{V}{3600}\right)^3 T_{start}^2 \quad \ldots\ldots 6)$$

$$T_3 = N_3 T_{start} = T_{stop} \left(\frac{V}{3600}\right)^3 T_{start}^3 \quad \ldots\ldots 7)$$

And it can be continued indefinitely. To obtain the total number of the stopped vehicles, we have to add together the number of vehicles in all the groups.

$$N_n = N_1 + N_2 + N_3 + \ldots + N_x \quad \ldots\ldots 8)$$

and

$$N_n = T_{stop} \frac{V}{3600} + T_{stop} \left(\frac{V}{3600}\right)^2 T_{start} + T_{stop} \left(\frac{V}{3600}\right)^3 T_{start}^2 + \ldots\ldots\ldots\ldots\ldots\ldots 9)$$

As we see this equation is a geometrical series. It is also known that this sort of series can converge or diverge. The sum of the series is:

$$S_n = a(1 + r + r^2 + r^3 + \ldots + r^{n-1} \quad \ldots\ldots 10)$$

$$S_n = \frac{a(1 - r^n)}{1 - r} \quad \ldots\ldots 11)$$

where the condition of convergence is:

$$r \leqq 1 \quad \ldots\ldots 12)$$

To apply it to equation 9, the sum of the stopped vehicles (according to equation 11) is:

$$N_n = T_{stop} \frac{V}{3600} \left[\frac{1 - \left(\frac{V}{3600} T_{start}\right)^n}{1 - \frac{V}{3600} T_{start}} \right] \quad \ldots\ldots 13)$$

if;

$$\frac{V}{3600} T_{start} \leqq 1 \quad \ldots\ldots 14)$$

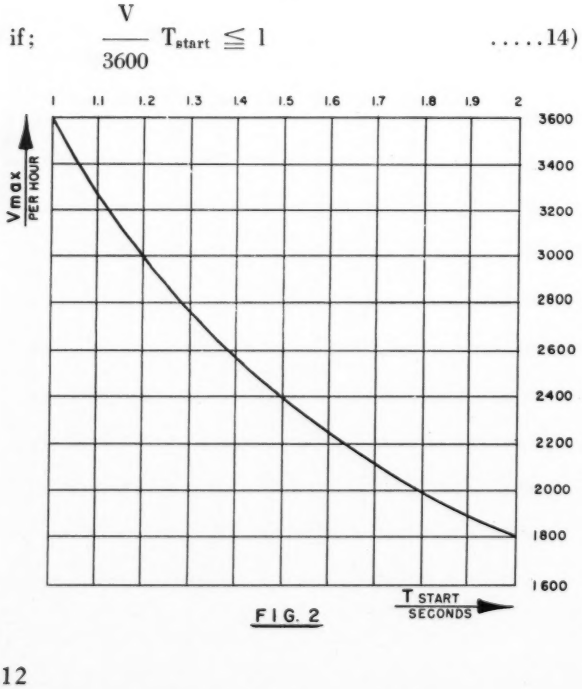


FIG. 2

The creation of $N_1, N_2, N_3 \ldots$ groups is imaginary; therefore, to get the final result we have to extend the summation to the infinite.

$$N_{stop} = N_{n \to \infty} = T_{stop} \frac{V}{3600} \cdot \frac{1}{1 - \frac{V}{3600} T_{start}} \quad \ldots\ldots 15)$$

Reducing equation 15 gives the number of vehicles stopped by T_{stop} time as:

$$N_{stop} = \frac{T_{stop}}{\frac{3600}{V} - T_{start}} \quad \ldots\ldots 16)$$

or in another form

$$N_{stop} = T_{stop} \frac{V}{3600} \frac{1}{1 - \frac{V}{3600} T_{start}} = T_{stop} \frac{V}{3600} F_s \quad \ldots 17)$$

F_s was called Sluggishness Factor by Herbert S. Levinson, who originally developed it in 1956.[1]

2. Maximum Theoretical Capacity

It has been mentioned in the previous paragraph that:

$$N_n = T_{stop} \frac{V}{3600} \left[\frac{1 - \left(\frac{V}{3600} T_{start}\right)^n}{1 - \frac{V}{3600} T_{start}} \right] \quad \ldots\ldots 13)$$

The formula is true if

$$\frac{V}{3600} T_{start} \leqq 1 \quad \ldots\ldots 14)$$

The implication of formula 14 is very important because this is the condition of convergence. We have to examine what it means in the traffic engineering field. T_{start} is the time duration that is needed to start each vehicle in the stopped line. It is a function of human factors, weather and road conditions and the starting ability of vehicles. Let us suppose its value is given to us. In this case the only variable in the 14 equation is V.

$$V_{max} = \frac{3600}{T_{start}} \quad \ldots\ldots 18)$$

The curve of this function is given in Figure 2.

And V must not be higher than $3600/T_{start}$ because mathematically this is the highest volume allowing convergence and physically is the highest volume which will not cause a never disappearing congestion. Therefore, this volume is

1. Herbert S. Levinson: The Sluggishness or Queueing Factor. **Traffic Engineering**, June 1956.

considered as Maximum Theoretical Capacity. The examination proves that even in the case of a theoretical lane there is an upper limit of hourly volume that is possible without congestion. Secondly, the Maximum Capacity is independent of speed. At this point we would like to quote O. K. Normann about "Capacities of Uninterrupted Flows." "It is highly significant that there has been no measurable change over a twenty-year period in the maximum possible number of vehicles that two lane and multilane highways can accommodate when the flow is not interrupted by intersections. Result of studies conducted between 1934 and 1941 showed that the total possible capacity of a two-lane highway and the possible capacity per lane of a multilane highway was 2000-2200 vehicles per hour".[2]

. . ."Extensive studies conducted during recent years by the California Division of Highways[3] and by the Bureau of Public Roads in cooperation with a number of state highway departments shows that these same figures continue to be applicable."

Yes it is truly "significant" because the foregoing study mathematically proves that there is an upper limit of capacity of uninterrupted flows. If the hourly volume reaches the upper limit, then even the shortest stop in the free flow, which affects only one vehicle, will affect every following one forever.

This condition will create a newer disappearing congestion which moves as a congestion-wave in the opposite direction of the traffic flow.

However, the approaching volume even can be higher than the theoretical maximum (V maximum), because nothing regulates the traffic volume entry into a facility under present practice. What happens then? From the examination of the equation we can say it will create an ever growing congestion. The number of stopped vehicles will grow steadily, affected by the shortest disturbance in the free flow. The only help to solve this steadily growing congestion is to reduce the hourly volume.

Naturally, there are no ideal conditions in practice. On the contrary, the conditions are more serious. There are many reasons which cause stoppage of vehicles, namely; stop signs, traffic signals, railway crossings, parking cars, even poor driving.

However, freeways and other highly developed facilities approach very nearly the requirements of the theoretical lane. Therefore, it would be interesting to see how the theory can be applied in practice.

3. Practical Considerations

As it was proved, the Maximum Theoretical Capacity per hour without congestion is,

$$V_{max} = \frac{3600}{T_{start}}$$

where T_{start} is a complex function of human and other factors. However, it is a factor quite easily measured in practice.

Figure 3 shows the result of our measurements. The conditions were not ideal. It was done during the rush

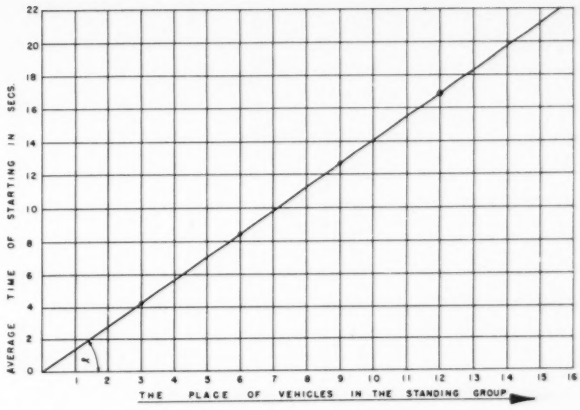


FIG 3

hours, on a one-way concrete road with light snow-flurries. The number of mixed type vehicles was five hundred and the interruptions of flow were created by signal lights. The location was isolated because the nearest signalized intersection was farther than 4000 feet away. The times of starting were measured from the beginning of the green light until the third, the sixth, the ninth and the twelfth vehicles started. Having this data we drew up Figure 3 in which the plotted values are averages.

As was defined in the first paragraph, T_{start} is the interval of time between the starting of successive vehicles in the stopped line. So it is equal from Figure 3, to

$$T_{start} = \frac{\text{TIME OF STARTING}}{\text{THE PLACE OF VEHICLE}} = \tan \alpha \quad \ldots\ldots 19)$$

Because of the linear equation T_{start} is constant, and in our case

$$T_{start} = 1.4 \text{ seconds} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 20)$$

and the Maximum Theoretical Capacity with this Figure is:

$$V_{max} = \frac{3600}{1.4} = 2571 \text{ V.P.H./Lane}$$

We would like to introduce a few comparative figures from experience, measured in the past few years, by different authors. Eugene J. Lessieu[4] measured high volumes on ramps, his highest volume was 2270 V.P.H. per lane.

Karl Moskowitz[5] wrote the following about freeways: "The very highest lane volumes observed for a full hour were in the order of 2400 at 45 M.P.H." He also points out in explaining his charts, that they "could not measure the speed in many cases because of occurrences of congestion —during parts or all of the hour." About the very high volume of 2437 V.P.H. he notes that there "the two lane roadway expands to three lanes about 800′ ahead of the observation point, therefore, no backpressure can develop." These studies show that the method given in the second paragraph of this paper to obtain the Maximum Capacity, is validly based. When the volume approaches the Theoretical Maximum Capacity the conditions become

2. Research to Improve Tomorrow's Traffic. **Traffic Engineering**, April 1959.
3. **Freeway Capacity Study**, 1956 G.M. Webb and K. Moskowitz. Highway Research Board **Proceedings** 1957.
4. Operational Characteristics of High Volume On-Ramps, 1957 ITE **Proceedings**, p. 16.
5. Research on Operating Characteristcs of Freeways, 1956 ITE **Proceedings**, p. 87.

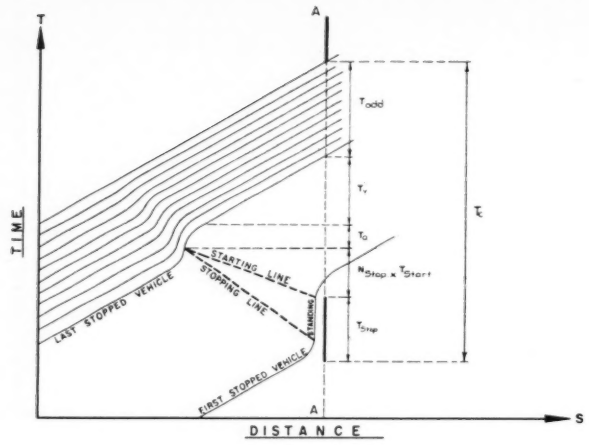


FIG. 4

very critical and congestion — "can occur quickly even from a single driver's faulty maneuver or hesitation." This is exactly what the theory indicates, so we can conclude that this method of determining the Theoretical Maximum Capacity without congestion can be applied to freeways or to similar high type facilities. It can demonstrate the need of providing routes, or it can prove that a congested location is suffering from the appearance of high volumes.

Furthermore, determination of the Maximum Theoretical Volume of a signalized intersection, is also of interest. In the next section, among other things, this will be the subject of examination.

4. Theoretical Capacity in the Case of Periodically Interrupted Flow

In the following paragraph all the conditions stated in the first section will apply with one exception. Namely, instead of having one stop, we will have periodic stops. Simply, our roadway is a one-way ideal lane with a signal light on it, but with no cross-street or cross-traffic.

In the first section we had only one stop and after that unlimited time to solve the resulting congestion. But in the present case the GO time is limited by the periodically repeating stops.

Our purpose is now to find the minimum GO time needed for the stopped vehicles to pass the stop line, $\overline{AA}$ (See Figure 4).

Of course, there is only one cycle of operation shown in Figure 4. On the basis of this drawing we can write:

$$T_{go} = N_{stop} \cdot T_{start} + T_a + T_v + T_{add} \quad \ldots\ldots 21)$$

where:

T_{start} = starting time for each vehicle.
N_{stop} = the number of stopped vehicles.
T_a = the time needed for accelerating the last stopped vehicle.
T_v = traveling time to the stop line $\overline{AA}$ of the last stopped vehicle after acceleration with constant speed.
T_{add} = an additional time.

This additional time is important and will be discussed. It is necessary to provide for the vehicles arriving after the stopped group which have to decelerate and accelerate.

In the first section we have shown how many vehicles (N_{st}) will be stopped by the interruption for T_{stop} second. However, we did not discuss what happened to the following vehicles. These vehicles still cannot continue traveling with their original constant speed. They have to decelerate and then accelerate because of the slowly accelerating group ahead of them. The magnitude of this deceleration-acceleration process decreases from the first following vehicle to those after, until it disappears. (See Figure 4.)

Summarized, a stop applied to a constant flow of vehicles will create a fully stopped group (N_{st}), then after the deceleration - acceleration process the flow becomes smooth again. The time between the crossing of the stop line by the last stopped vehicle and the crossing by the first smoothly running one will be called additional time.

It can be seen that the next stop signal can not be given until the above effect of the previous one disappears, without increasing congestion occurring. So the described time between stops will be the necessary minimum GO time.

Now we will discuss all the part times of the minimum GO time expressed in Formula 21 in detail.

First of all, $N_{stop} \cdot T_{start}$ was discussed in the previous paragraphs. This is the time needed to start the standing group of vehicles. The next one is T_a time for accelerating the last stopped vehicle. It is known about and has been discussed in many articles.[6]

$$T_a = \sqrt{\frac{1.36\,S}{a}} \Bigg|_{\text{from } V=0}^{\text{to } V=\text{constant}} \quad \ldots\ldots 22)$$

where:
S = distance in feet.
a = acceleration in m.p.h./secs.
In our case, T_a is to be calculated from V = O, to V = constant.

If the last of the stopped vehicles has accelerated to constant speed but has not yet arrived at the line $\overline{AA}$, it will continue traveling with V constant speed for T_v seconds to the line $\overline{AA}$.

$$T_v = \frac{S}{V_c} \Bigg|_{\text{from } V=\text{constant}}^{\text{to } \overline{AA}} \quad \ldots\ldots 23)$$

which is also known from physics.

In Figure 5 we can see the sum of these times called T_{gl} as a function of the number of stopped vehicles.

$$T_{gl} = N_{st}\, T_{start} + T_a + T_v \quad \ldots\ldots 24)$$

The speed of the steady uninterrupted flow in Figure 5 was taken as constant at 30 m.p.h. It is interesting to note that the curve can be approximated with a straight line (see dotted line in Figure 5 from the fourth vehicle on).

$$T_{gl} \simeq A + B\, N_{st} \quad \ldots\ldots 25)$$

6. For example: Traffic Eng. Handbook, 1950 Edition, p. 66.

Formula 25 gives the expression of this line where A and B are constants. The T_{gl} time expressed by the 25th equation is slightly higher than the exact value, especially at small volumes. Recognition of this is important because it allows definition of an average headway or traveling time (T_{tr}) for vehicles crossing the $\overline{AA}$ line.

$$T_{tr} = B = \tan \propto \qquad .....26)$$

with the data of Figure 5 this traveling time is:

$$T_{tr} = 2.1 \text{ seconds}$$

We should go further and calculate the additional go time (T_{add}).

The technique of calculation will be the same as we used in the first section. The last car of the standing group travels to $\overline{AA}$ in $T_a + T_v$ time. During this time a group of vehicles (N) arrives on the scene and they carry out the decelerating-accelerating process.

The number of vehicles in this group:

$$N_1 = (T_a + T_v) \frac{V}{3600} \qquad .....27)$$

Using the average traveling time T_{tr}, the time T_1 they need to cross $\overline{AA}$ is:

$$T_1 = N_1 T_{tr} = (T_a + T_v) \frac{V}{3600} T_{tr} \qquad .....28)$$

During T_1 time a second group N_2 arrives:

$$N_2 = T_1 \frac{V}{3600} \qquad .....29)$$

The crossing time of the second group is:

$$T_2 = N_2 T_{tr} = (T_a + T_v) \left(\frac{V}{3600} T_{tr}\right)^2 .....30)$$

We can repeat it for all the following imaginary groups. Finally we get a geometrical series again.

$$T_{add} \underset{n}{1} = T_1 + T_2 + T_3 + \ldots + T_n \qquad .....31)$$

$$T_{add} \underset{n}{1} = (T_a + T_v) \frac{V}{3600}$$

$$\left[1 + \frac{V}{3600} T_{tr} + \left(\frac{V}{3600} T_{tr}\right)^2 + \ldots\right] .....32)$$

Using formulas 10, 11, and 12

$$T_{add} \underset{n}{1} = (T_a + T_v) \frac{V}{3600} T_{tr} \left[\frac{1 - \left(\frac{V}{3600} T_{tr}\right)^n}{1 - \frac{V}{3600} T_{tr}}\right] ....33)$$

which if $n \to \infty$ gives the additional time;

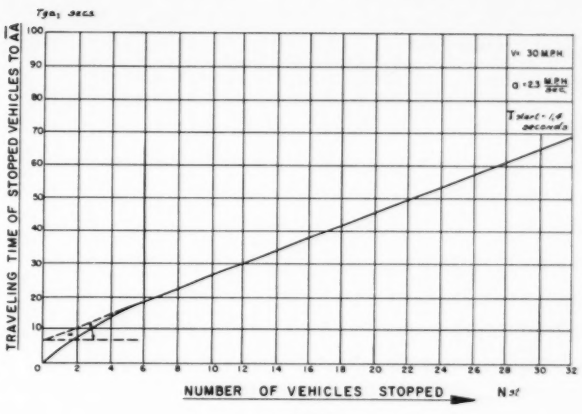


FIG. 5

$$T_{add} = (T_a + T_v) \frac{1}{\frac{3600}{V\ T_{tr}} - 1} \qquad .....34)$$

Let us examine the condition of convergence which is, according to formula 12, $r \leqq 1$. As we saw in the second paragraph, the physical meaning of this condition is the maximum capacity without congestion.

$$\frac{V}{3600} T_{tr} \leqq 1 \qquad .....35)$$

and

$$V_{max\ pr} = \frac{3600}{T_{tr}} \qquad .....36)$$

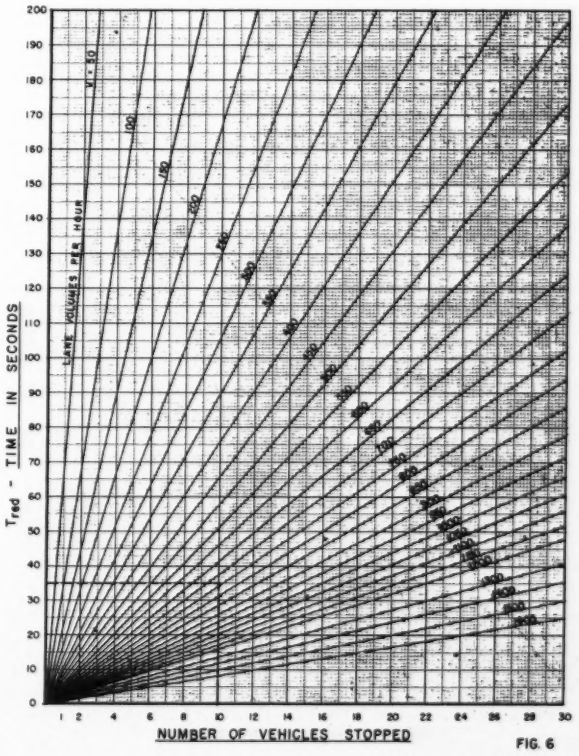


FIG. 6

Formula 36 gives the Maximum Capacity of periodically interrupted flow. If $T_{tr} = 2.1$ seconds, as we used in connection with Figure 5, then:

$$V_{max\ pr} = \frac{3600}{2.1} = 1714 \text{ V.P.H./Lane}$$

$V_{max\ pr}$ should be used, when the conditions are ideal and when the steady flow of vehicles is periodically interrupted by stops and where the go time is also limited.

Furthermore, this is the upper limit of carrying capacity of the intersection of two lanes. We will see that it can only be reached when there is no cross street traffic, which is purely a theoretical condition.

Summarized, we arrived at this Maximum Capacity as a supplementary result. Our purpose was to find the Minimum GO time, given by Formula 21. Substituting the additional time of Formula 34 into it gives the minimum GO time.

$$T_{go\ min} = N_{st}\ T_{start} + (T_a + T_v)\left[1 + \frac{1}{\frac{3600}{V\ T_{tr}} - 1}\right] \quad \ldots\ldots 37)$$

where,

N_{st} . T_{start} = the number of stopped vehicles by T stop time, given in the first section.
T_a = accelerating time (Figure 5).
T_v = traveling time with constant speed.
T_{start} = average starting time for a vehicle.
T_{tr} = average traveling time per vehicle.

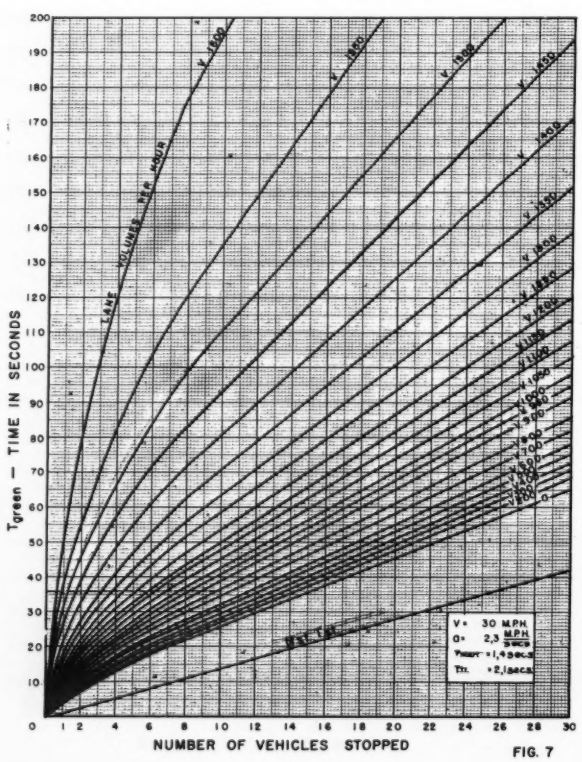


FIG. 7

5. Timing of Signals of Ideal, Isolated Intersections

In this section we will apply the result of the previous section to an ideal intersection, ideal meaning:

a) an intersection of two one-way lanes,
b) steady flow of vehicles on both approaches, the streams not influenced by adjacent signals.
c) constant spacing between vehicles outside of the zone of influence of the signals.
d) constant speed.

Substituting T_{red} for T_{stop} in equation 16

$$T_{red} = N_{stop}\left(\frac{3060}{V} - T_{start}\right) \quad \ldots\ldots 38)$$

where

T_r = the duration of red phase in seconds.
N_{st} = the number of vehicles stopped by the red light.
T_{start} = the average starting time of vehicles in seconds.
V = the hourly volume of traffic approaching the intersection on one of the lanes.

Knowing the other variables, equation 38 can be solved for N_{stop}, which gives the storage requirements on the approaches to the intersection.

To avoid unnecessary calculations Figure 6 was developed, which shows the relation between red time, volume, and the number of vehicles stopped. There is only one factor involved which was measured in the field, namely T_{start} 1.4 seconds. This value can be changed to correspond with local conditions.

In practice there are known: the number of stopped vehicles N_{st} which the storage place can accommodate, the hourly volume of vehicles V, and the number of lanes available. From these data we can get the duration of red time. For example the maximum number of stopped vehicles N_{st} allowable on lane "A" is 10 and the volume of traffic V is 750 v.p.h. Applying these values to Figure 6 gives,

$$T_{red} = 35 \text{ seconds}$$

which is the maximum duration of the red time, without overflowing the storage area.

Now the next step is to develop a similar diagram for green time.

Substituting T_{green} time for T_{go} in equation 37,

$$T_{gr} = N_{st}\ T_{start} + (T_a + T_v)\left[1 + \frac{1}{\frac{3600}{V\ T_{tr}} - 1}\right] \quad \ldots\ldots 39)$$

From this equation Figure 7 can be constructed. All the applied constants are shown in the table of Figure 7. It must be noted again that all these constants can be modified to suit local conditions. To continue the previous example ($V = 750$, $N_{st} = 10$) we can find the length of the go time from Figure 7 which is

$$T_{green} = 36 \text{ seconds.}$$

We saw that on the basis of the previous formulas, two diagrams, Figure 6 and Figure 7, were developed. From them we can find the maximum allowable red time and the following necessary green time. So far, we have considered only one of the two intersection approaches. Now we are going to consider both main (A) and cross (B) lanes together. See Figure 8.

Until now we have discussed the alternation of red and green lights, without amber clearance intervals. From

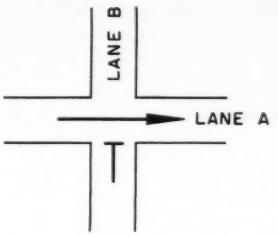


FIG. 8

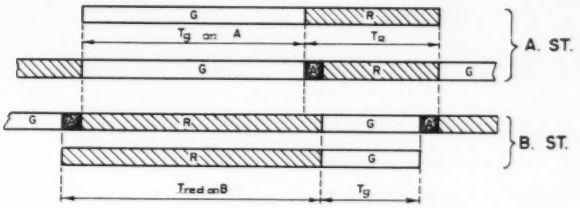


FIG. 9

now on, because of the necessity of providing clearance time in practice, we have to consider amber time as well. We will consider the amber as the beginning of the red time. Using this definition the signal timing of our intersection is drawn in Figure 9.

The reason for choosing this definition is as follows. The amber time has to be considered as a part of the red time, because motorists consider it as a sign to stop, if they are able to do so. Those who can stop apply their brakes, decelerate, and finally stop at approximately the beginning of the red.

Looking at it from another angle the main street amber time is unavailable to the cross-street movement, because the stored vehicles on it cannot start immediately after the end of the main street green. So, the main street amber time appears as cross-street red and vice versa. This definition results, as seen in Figure 9, in

$$T_{gA} + 2T_a = T_{rB} \quad \ldots\ldots 40)$$
$$T_{rA} = T_{gB} + 2T_a \quad \ldots\ldots 41)$$

Having this we can continue the previous example, and see what happens to Lane "B". (T_{gA} = 36 seconds, T_{rA} = 35 seconds and T_a = 5 seconds.)

$$T_{rB} = T_{gA} + 2T_a = 36 + 10 = 46 \text{ secs.}$$
$$T_{gB} = T_{rA} - 2T_a = 35 - 10 = 25 \text{ secs.}$$
$$T_c = T_{rB} + T_{gB} = T_{rA} + T_{gA} = 71 \text{ secs.} \quad \ldots\ldots 42)$$

We would like to emphasize again that the amber times are included in the red according to the foregoing definition and the cycle length T_c given by equation 42 is the sum of this "red" and the green time.

Now using our two charts, Figure 6 and Figure 7, we can find what volumes of N_{st} and V correspond with 46 seconds red and 25 seconds green time on the "B" lane.

Volume on "B" . . . V = 475 v.p.h.

The number of stopped vehicles, N_{st} = 7.4 (say 8). Figure 10 shows all the data of our example, plus the capacity of our intersection operating with this cycle length.

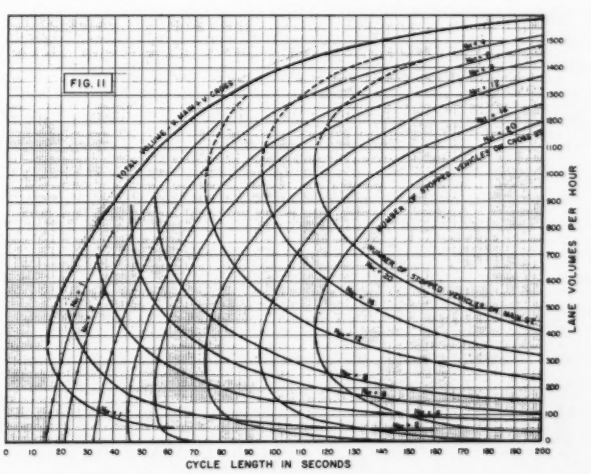
This method of solution is tedious and does not clearly indicate the connection between the intersectional volume (on both lanes A and B) and the cycle length. For this reason we developed Figure 11, from Figure 6 and Figure 7, which shows this connection including the parameter N_{st}, the number of stopped vehicle on main (A) and cross (B) streets.

However, it is also important to see that when an engineer obtains the cycle length, splits and the corresponding number of stopped vehicles, using the above method, perhaps he finds that there is not adequate storage place for these vehicles. In this case he can favor the approach with the inadequate storage and shorten the length of the red light on it, which will result in fewer stopped vehicles. However, a shorter red on his favored street will cause a short green on the secondary one, which is less than the necessary minimum green time and will cause congestion on the secondary street. It also has to be seen that the green time does not depend solely upon the volume but the length of the red light as well.

Intersectional signal timing can be quickly solved using Figure 11 to determine cycle length and then either Figure 6 or 7 to determine a split. In Figure 12 there are three sketches to show how to use the charts with the same numerical example used previously (V = 750 v.p.h. on main street and V = 475 v.p.h. on cross lane). The

ON	V VOLUME V. P. H.	T GO TIME SECS.	T STOP TIME SECS.	T CYCLE LGTH SECS.	TOTAL VOLUME $V_A + V_B$
A. ST. (MAIN)	750	36	5A+ 30R= 35	71	1225
B. ST. (CROSS)	475	25	5A+ 41R= 46	71	

FIG. 10



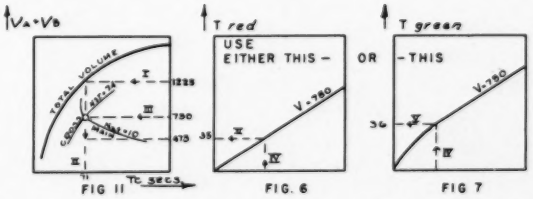
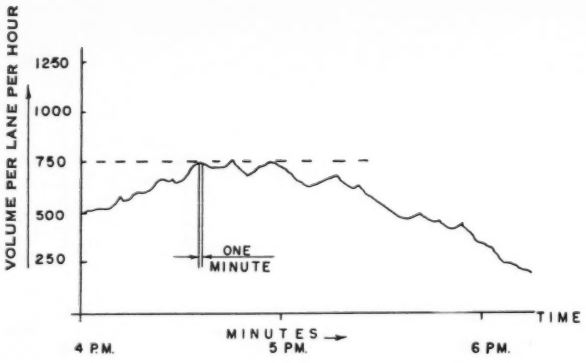


FIG. 12



SUPPOSED VOLUME CHANGES IN TRAFFIC FLOW

FIG. 13

roman numerals and the arrows show the order of steps to be taken. We would like to emphasize that Figure 11 shows the most efficient cycle length for any given intersectional volume ($V_a + V_b$). Most efficient means a shorter cycle length would cause congestion and a longer one unnecessary delays. The volume in Figure 11 is the Theoretical Capacity of an intersection of two ideal lanes at this cycle length. A further advantage of the method is that it gives not only the theoretical splits and the cycle length, but the number of vehicles stopped by the signals on both approaches.

This is believed to be new and important from the viewpoint of vehicle storage and congestion. Another point has to be seen on the basis of this study. The green time that has to be given for signals depends upon the appearing volume — as it is known — however, it does not depend upon the volume only, but also upon the interrelationship of the red and green times.

6. Summary and Minute Volume Counting

A further discussion of the Sluggishness Factor leads us to the expression of the Maximum Theoretical Capacity of an ideal lane without congestion (Formula 18). Applying 1.4 seconds starting time resulted in a numerical value of maximum capacity which is $V_{max} = 2571$ v.p.h. per lane. This theoretical volume can be reached in practice for a short time only when the conditions are ideal, for example in the case of uninterrupted flows on freeways. However, approaching the theoretical maximum the balance of traffic flow becomes very sensitive and the smallest disturbance in it, like a lane change, or short stop, or even a slow down by one vehicle can cause a serious congestion.

When the conditions are still ideal, but in the case of two crossing lanes, where the traffic flow has to alternate either by itself or is regulated by police, signals, etc., then the volumes can reach only the Practical Maximum Capacity without congestion (Formula 36), which is according to our constant ($T_{tr} = 2.1$): $N_{h\ max} = 1714$ v.p.h.

This volume cannot be reached at all because of the necessary clearance time in practice. Figure 10 shows the maximum volumes; for example, 1380 vehicles on both lanes together when $T_c = 100$ seconds. Theoretically the Practical Maximum Capacity can be approached, if the cycle length is extended to the infinite.

To judge the value of this traffic signal timing method from a practical viewpoint is not easy.

It was not tailored for use in practice, and discusses ideal, isolated intersections only. Our aim was primarily to develop purely theoretical methods for use in the traffic field. The author strongly believes that the only successful way to approach technical problems leads through either physical or theoretical research. It would be advantageous to know the basic theories of traffic operations in the traffic engineering field and to adapt the theory for use in practice, as is done in other engineering fields. Many such factors are already developed in our profession: e.g., in timing of signals, the capacity for parking, heavy vehicles, turning movements, etc.

The hourly volume of traffic was taken as being constant, which is not so in practice. Therefore, we have to devote some time to deciding what practical volumes should be applied as hourly volumes in our charts and formulas.

The hourly traffic at an intersection varies according to Figure 13. What is the hourly volume in this case for us to use in calculations? The changing volume of traffic should be considered per signal cycle because during a red phase the number of stopped cars depends upon the momentary arriving volume, and the green phase has to accommodate this volume in every cycle, or periodic congestion can occur, as was proven previously in Part 4. So the necessary signal timing is determined by the momentary conditions. Consequently, it is not advisable to use an average volume because the application of such method would cause congestion in that minute, when the actual volume exceeded the average figure.

To apply our results properly, the traffic count has to be recorded for each cycle. However, there is no cycle length given when we want to time signals. On the contrary, to determine it is one of our aims. Therefore, on the basis of our practical knowledge, it seems to be reasonable to record a count of traffic every minute.

To those who want to use our method, we suggest recording the count of traffic in every minute, and expanding the highest Minute Volume to an hourly figure by multiplying it by sixty. By doing so, we believe there cannot be congestion even during peak hours. On the other hand, by applying other count figures, the signal could be the cause of congestion.

An isolated intersection either of one-way or two-way streets, without turns or with a negligible volume of turns, without parking, etc.—a reasonably ideal situation—can be the subject to test our method in practice. If the number of lanes is more than one, we have to consider the highest lane volume. As discussed previously, we cannot use an average lane volume figure. In the case of more complex intersections, the charts can be used, but the well-known factors for different traffic movements, and for different type vehicles should be applied. If we want to apply this method for the retiming or checking of existing signals, the count location should not be within the area of influence of an adjacent signal.

Finally, the theoretical timing of synchronized or interconnected signal systems require a further study, which subject would also be of interest.

(Continued on page 58)

Chicago Plans Its Future

By Department of City Planning
Chicago, Illinois

If your last visit to Chicago was for the 1952 Institute of Traffic Engineers meeting, you can expect to see a vastly changed city this September.

Chicago's housing and renewal agencies have cleared or acquired nearly 720 acres of blighted land for development of modern residential and commercial buildings.

Major portions of the Congress Street expressway, unique for its median strip rapid transit line, are now in operation. The remaining portion is scheduled for completion this fall.

The 7¾-mile Calumet Skyway was opened in 1958. This six-lane elevated roadway passes over much of the city's busiest industrial areas on the southeast side, to a connection with the Indiana toll road.

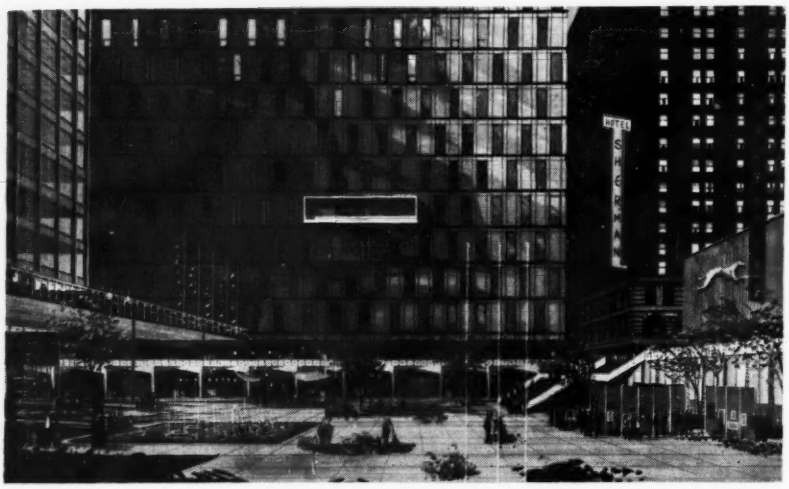
The Northwest expressway, due for completion this September, will connect downtown Chicago with Chicago-O'Hare International Airport. The South expressway is scheduled to be in operation by 1962. These routes will also contain rapid transit lines. Land acquisition is under way for the Southwest route, scheduled for completion by 1965.

You will see new private apartment communities along Lake Michigan on the south side. Lake Meadows, between 31st and 35th streets, rises on 101 acres of land which once contained some of Chicago's worst slums. These slums were cleared by the Chicago Land Clearance Commission and resold for private development. Nine high-rise residential buildings, a shopping center, an elementary school and a park have been completed. Two apartment buildings in the Prairie Shores development have been completed, and a third is under construction. When completed, both areas will provide a total of approximately 3,700 dwelling units for middle-income families.

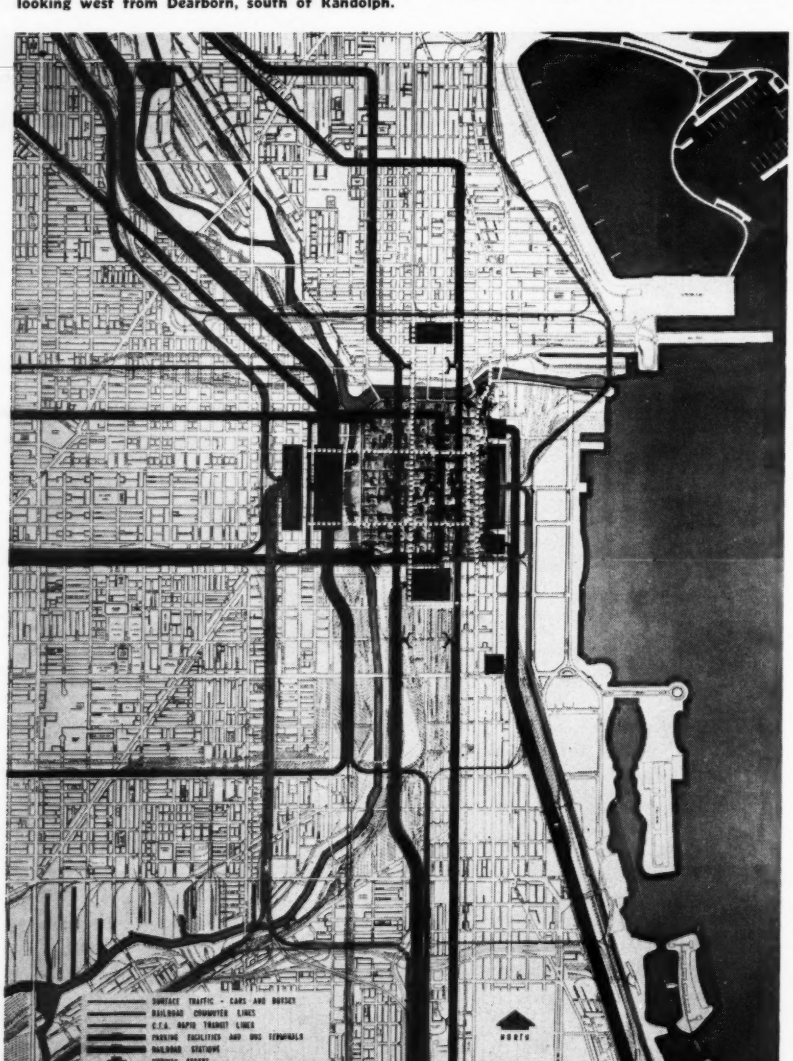
On the west side, areas are being redeveloped for light industrial and commercial uses.

TRANSPORTATION CENTER. An Airlines Terminal Building (center) would house depots for airport buses, reservation offices, and a heliport. The center would attract additional commercial development west of the Chicago River. View is looking northwest from Jackson Boulevard.

LAKE MEADOWS. Nearly 2,000 modern apartments in nine buildings are now occupied in the Lake Meadows development. It covers 101 acres along the lake, between 31st and 35th streets. Previously blighted land was cleared by the Chicago Land Clearance Commission and resold for private development.



CIVIC CENTER. In the block east of the present City Hall-County Building (background) will be a Civil Courts Building (left), City-County Office Building and a two-level civic plaza. View is looking west from Dearborn, south of Randolph.



PROPOSED TRAFFIC FLOW. This central area map indicates general volumes of traffic to be carried by surface, rail, and rapid transit lines, under proposals of the plan.

Near the University of Chicago, the 909-acre Hyde Park-Kenwood area has been designated for comprehensive renewal treatment. Town houses and a shopping center have been built in two Land Clearance Commission projects. The city's Community Conservation Board is administering a program of limited clearance and rehabilitation, in cooperation with property owners and local citizens' groups.

The Chicago Housing Authority now operates approximately 19,000 dwellings for low-income families in 33 project areas. Another 10,000 units are planned or under construction.

Coordination and review of Chicago's vast renewal and capital improvements program are the responsibilities of the Department of City Planning. The department was established in January 1957, as an executive arm of city government. Mayor Richard J. Daley appointed Ira J. Bach as the department's first commissioner.

On that date, the Chicago Plan Commission was reconstituted as the advisory and policy-making body for the city's planning program.

Previously, planning in Chicago had been conducted primarily as a citizens' responsibility under the Plan Commission. Its operations were not actually a part of the day-to-day workings of government.

In 1909 the commission was established to carry out the original Plan of Chicago. This plan marked the first attempt by a major American city to redesign and rebuild on a comprehensive basis. Many of its proposals—the lake front development, the park system, the city's major thoroughfares and the bordering forest preserves — are now realities.

The new department and the strengthened Plan Commission are designed to meet the planning needs of Chicago's growing population and advancing technology.

Maintaining and expanding the General Plan of Chicago is the department's first responsibility. Staff members are now engaged in the development of a comprehensive revision of the plan by 1962.

The department presented the first step of the revised plan to Mayor Daley and the Plan Commission in August 1958. It was the Development Plan for the Central Area of Chicago—a 22-year program for revitalizing the heart of the city. Eighty per cent of

the plan's 1½ billion dollar cost would be financed by private investment.

Major proposals are for government buildings, a four-year campus for the University of Illinois, transportation facilities, recreational areas and 50,000 new dwelling units.

The Chicago Public Building Commission has selected architects for a Civic Center, to be built in the block immediately east of the present City Hall-County Building. This key proposal will provide two 21-story buildings, to house civil courts and city and county offices, and a two-level civic plaza.

The plan calls for a University of Illinois campus in the area south of the Loop, on land now occupied by railroad tracks and terminals. Traffic access from the south side would be improved in this area, through two major arteries on either side of the campus. The Franklin expressway would be constructed to connect Congress Street with the south and southwest routes. State Street would be widened and improved for expanded capacity.

Rail facilities would be relocated to an expanded Union Station, west of the Chicago River. Negotiations with the lines involved are now underway.

The consolidated rail terminal would be an important step in creating a comprehensive Transportation Center. Included would be terminal and transfer facilities for airport buses, rapid transit and surface lines.

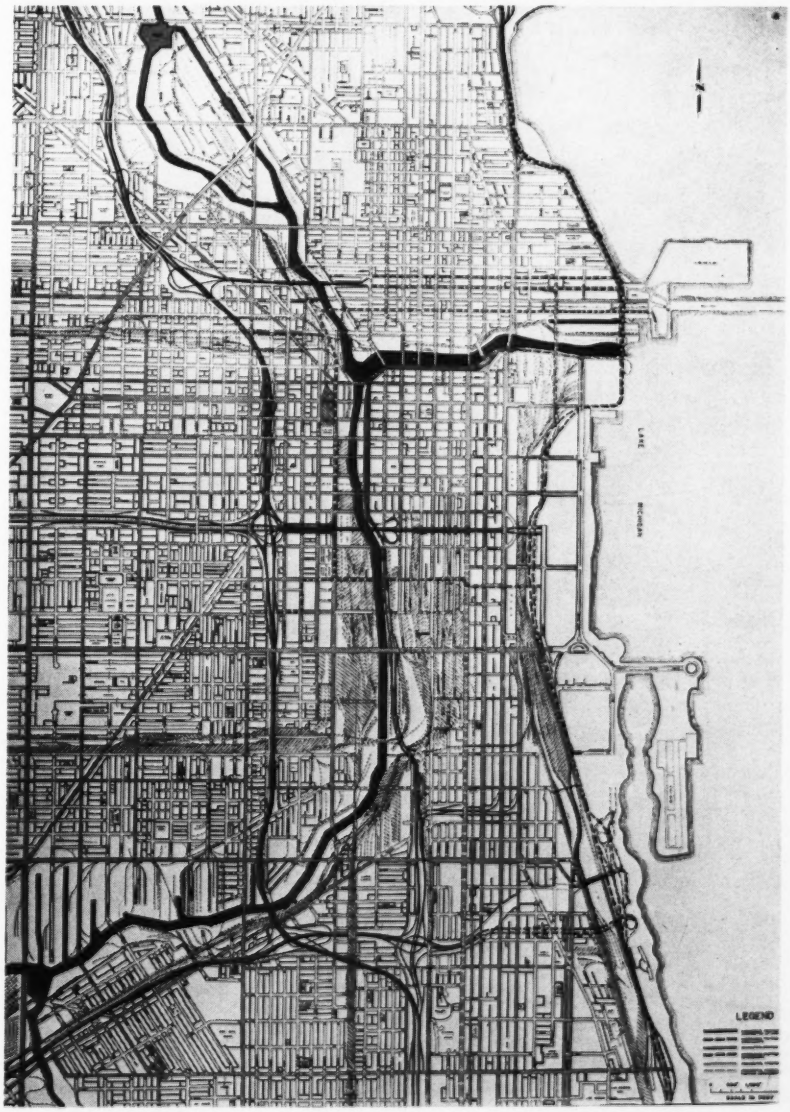
The center would also contain major parking facilities connecting with the Northeast Expressway. This development would encourage commercial expansion west of the river.

Another plan proposal was for expanded Federal facilities on the south end of the Loop. The General Services Administration will develop a two-building Federal Center in the area called for in the plan. It will include a plaza on the block now occupied by the present Federal building.

Several residential redevelopment projects in the central area are now underway. The Chicago Land Clearance Commission's North-LaSalle and Harrison-Halsted projects, Chicago Housing Authority construction and the Community Conservation Board's Near West Side urban renewal area will provide some of the 50,000 new units proposed in the plan.

Private developments since the plan's announcement are achieving several

UNIVERSITY OF ILLINOIS. A new four-year Chicago campus for the University of Illinois would be developed on land now occupied by railroad tracks and terminals, south of the Loop. New apartment buildings (right) would rise east of State Street. View looking north from 14th and State streets.



PROPOSED TRAFFIC PLAN. These are the preferential streets, distributor roadways and expressways proposed or under development in the central area.

key central area objectives. High-rise apartment structures will be built along the north bank of the river. Two, in the Marina City development, will rise to a height of 60 stories and will be the world's tallest apartment buildings.

Many commercial buildings planned or now under way relate closely to Central Area Plan measures. Several firms are expanding in the area west of the Loop, near the proposed Transportation Center.

Major portions of the Congress, Northwest and South expressways serving the central area have been completed. These roadways will channel through traffic around the heart of the city. Still closer to downtown, systems of outer and inner ring roads will provide additional access and capacity. These distributor roadways, together with the city's perimeter parking facilities, will diminish Loop traffic congestion.

Recreational proposals would serve an expanded central area population. A filled-in island off the shore of Oak Street beach would offer bathing, parking and small boat mooring facilities. Redesign of the existing Grant Park would make it more accessible and usable for central area workers and residents.

Accomplishing the objectives of the Central Area Plan and of other planning proposals requires action on the part of many municipal agencies and private investors. It is the function of the Department of City Planning to provide a long-range framework for these activities.

The Mayor's Urban Renewal Committee establishes over-all policies for the renewal program. Members include Commissioner Bach and executive officers of Chicago housing, redevelopment and conservation agencies.

Each year the department publishes a Five Year Capital Improvements Program for the Capital Improvements Program Committee. Commissioner Bach serves as chairman of this committee. Other members include commissioners of the departments of public works, aviation, water and sewers, and streets and sanitation, the Mayor's administrative officer, the comptroller, the president of the Board of Local Improvements and the director of the budget.

The program outlines the locations, expenditures and priorities for major projects of public agencies in Chicago.

The department also works with renewal and public works agencies on a technical staff level.

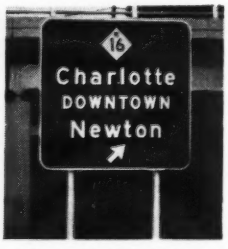
The expansion of Chicago - O'Hare International Airport, on the northwest side, is one of the city's major current improvements. Revenue bonds are financing construction of runways and other facilities for jet transportation.

On the far south side, in Lake Calumet, the Chicago Regional Port District is developing the city's largest bulk cargo harbor. It is the focal point of the only through route connecting the Great Lakes with the Mississippi Waterway.

Chicago has gained world recognition for its planning and engineering achievements — its lake front, boulevard system, bridge construction, and the reversal of the flow of the Chicago River.

Today, Chicago's planning program is guiding the development of new facilities and services to meet present and future needs. The success of this program is based upon the cooperative efforts of government agencies, private investors and citizens' organizations.

"Cuts maintenance to the bone"



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The Use of Electronic Computers

By William L. Mertz
Highway Engineer, Electronics Branch
Div. of Development, Office of Operations
BPR, U.S. Dept. of Commerce

AN ORIGIN AND DESTINATION traffic survey is conducted by interviewing a sample of the motoring public either at the roadside or in their homes to obtain information concerning the points of origin and destination of their travel and the mode of travel, i.e., passenger car, truck, mass transit, etc. Usually additional information is obtained but this discussion will be concerned with the origins and destinations of the different modes of travel.

Source of Basic Data

The geographical area under study is divided into sub-areas. The usual practice is to divide the area into districts, the districts being further sub-divided into zones and the zones subdivided into sub-zones. In some surveys a coordinate grid system is used to facilitate the systematic identification of any point within the area under study. Regardless of the system used, the origins and destinations of the motorists interviewed, are identified geographically within the survey area or, in the case of through travel, by the points on the periphery of the area through which the trips entered and/or exited. To simplify discussion, the sub-areas, including points of entrance and exit of the over-all area, to which origins and destinations are referenced will be called zones in this article.

During the survey, a percentage of the traveling public is interviewed. During compilation of the data, each trip is multiplied by an appropriate factor to obtain an estimate of the number of trips that would have been obtained if a 100 per cent sample had been taken. The desired result is a tabulation of all of the trips and their origins and destinations within the survey area for an average day. Using a simple hypothetical 4-zone example with hypothetical trip values, the tabulation for a given mode of travel would be as shown in Table I. If Table I is rearranged to emphasize the destinations of the trips, the result would be shown in Table II.

Tables I and II and Figure 1 show that the trips into and out of a particular zone are not equal. This is not a real situation because during an average day the trips into and out of a particular area must balance, otherwise

COMPUTERS AND THEIR APPLICATION TO TRAFFIC ENGINEERING

In order to keep traffic engineers informed on the ways in which they can take advantage of high speed computers in solving traffic problems, *Traffic Engineering* will carry a series of articles on "Computers and Their Application to Traffic Engineering."

As a background to the present series, readers are referred to an earlier article in *Traffic Engineering:*

"Basic Theory of Computers"
by Walter Kudlick,
Traffic Engineering, Vol. 28, No. 4., January, 1958
pp 20-23, 50.

The series will cover such subjects as:

Traffic Forecasting
Traffic Assignment
Traffic Simulation
Analysis of Traffic Data
Survey of Computers for Traffic Applications

Each article will carry a short glossary.

This month's article by W. L. Mertz discusses the use of a computer in forecasting interzonal traffic movements. An early issue will carry a second article by Mr. Mertz describing the use of a computer to assign trips to a network.

The entire series of articles is being coordinated for *Traffic Engineering* by D. L. Gerlough.

Table I
Tabulation of zone to zone movements from each origin to all destinations for a hypothetical four zone system.

Zone From	To	Trips	Zone From	To	Trips	Zone From	To	Trips	Zone From	To	Trips
1	1	5	2	1	4	3	1	7	4	1	8
1	2	6	2	2	25	3	2	12	4	2	20
1	3	8	2	3	18	3	3	40	4	3	25
1	4	12	2	4	15	3	4	20	4	4	50
Σ of trips from zone 1 =		31	Σ of trips from zone 2 =		62	Σ of trips from zone 3 =		79	Σ of trips from zone 4 =		103

Table II
Tabulation of zone to zone movements to each destination from all origins for a hypothetical four zone system.

Zone To	From	Trips	Zone To	From	Trips	Zone To	From	Trips	Zone To	From	Trips
1	1	5	2	1	6	3	1	8	4	1	12
1	2	4	2	2	25	3	2	18	4	2	15
1	3	7	2	3	12	3	3	40	4	3	20
1	4	8	2	4	20	3	4	25	4	4	50
Σ of trips to zone 1 =		24	Σ of trips to zone 2 =		63	Σ of trips to zone 3 =		91	Σ of trips to zone 4 =		97

the data would indicate that vehicles were accumulating in certain areas day after day which, of course, is not true. The usual practice is to add the trips going in one direction between particular pairs of zones to the trips going in the other direction between the same pairs of zones to produce a table of trips *between* zones without regard to direction as shown in Table III. This is called a Triangular Trip Table.

For computational purposes, depending upon the type and capacity of the computing equipment selected, it is often advantageous to "square" Table III as shown in Table IV.

Table III contains all of the information found in Table IV, but "squaring" facilitates easy computation of trip ends. For example, if conventional punched card tabulating equipment is to be used, summations of trip ends could be obtained from Table IV by summing each trip value having a common origin zone.

In Tables III and IV, and in Figure 2, the origins and destinations have ceased to have meaning. The presentation shows the desired trips between zones, without regard to direction, of what might be called the present traffic situation as indicated by sampling in an origin and destination survey. This configuration is the basis for forecasting desired traffic volumes between zones to some future design year.

Forecasting Procedure

When the forecasting problem first came to the attention of the traffic engineer, it was common practice to estimate the ratio of the area-wide total traffic for a particular mode in the design year to the area-wide present traffic and apply this growth factor uniformly to all desired traffic movements. This method is outmoded now because it failed to take into account the extreme differential growth that has taken place in recent years in the large cities.

A method designed to take differential growth into account was developed by Thomas J. Fratar[1] in connection with a Cleveland O & D Survey. It is analogous to the Hardy Cross method of successive approximations used in indeterminate structures and hydraulics. In its application, the growth of all of the trips having a terminus in a particular zone is estimated. This is done for each zone. This is analogous to fixed-end moments in an indeterminate structure. Carrying the analogy further, the first joint is released and allowed to rotate to some position of equilibrium which transmits moments to the connecting members. Each joint in turn is released and allowed to rotate to a position of equilibrium and locked. When all joints have been so treated, joint one is no longer in equilibrium because rotational forces have been transmitted back to it from the other joints. The process is repeated for all joints until they have no tendency to rotate when unlocked. The moments in the connecting members are now known. In this analogy the unknown moments would be the forecasted interzonal traffic volumes.

The Fratar formula is:

$$t'_{O\text{-}D} = t_{O\text{-}D} \cdot F_O \cdot F_D \frac{(L_O + L_D)}{2}$$

where:

$t'_{O\text{-}D}$ = the expanded or forecasted trips between the origin zone and the destination zone for this approximation.

$t_{O\text{-}D}$ = the present trips between the origin zone and the destination zone for this approximation.

F_O = the growth factor for the origin end of the trip transfer.

F_D = the growth factor for the destination end of the trip transfer.

L_O = the "location factor" of the origin which is equal to:

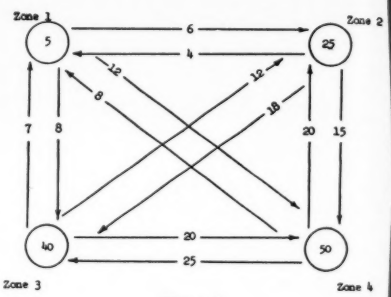


Figure 1
Schematic representation of zone to zone movements for a hypothetical four zone system.

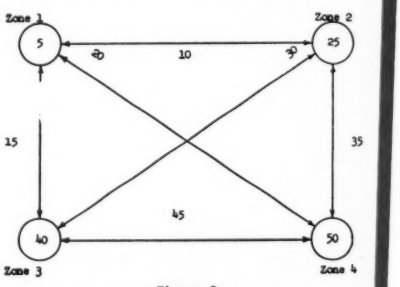


Figure 2
Schematic representation of movements between zones for a hypothetical four zone system.

$$\frac{\Sigma\,(t_O)}{\Sigma\,(t_O \cdot F_D)}$$

where $\Sigma\,(t_O)$ is the summation of all the trips that have an end in the origin zone and $\Sigma\,(t_O \cdot F_D)$ is equal to the accumulation of each trip that has an end in the origin zone multiplied by the growth factor of the zone situated at its opposite end.

L_D = the "location factor" of the destination zone which is equal to:

Table III
Triangular tabulation of movements between zones for a hypothetical four zone system.

Between Zones		Trips	Between Zones		Trips	Between Zones		Trips	Between Zones		Trips
1	1	5									
1	2	10	2	2	25						
1	3	15	2	3	30	3	3	40			
1	4	20	2	4	35	3	4	45	4	4	50

Table IV
Square tabulation of movements between zones for a hypothetical four zone system.

Zone From	To	Trips	Zone From	To	Trips	Zone From	To	Trips	Zone From	To	Trips
1	1	5	2	1	10	3	1	15	4	1	20
1	1	5	2	2	25	3	2	30	4	2	35
1	2	10	2	2	25	3	3	40	4	3	45
1	3	15	2	3	30	3	3	40	4	4	50
1	4	20	2	4	35	3	4	45	4	4	50
Σ of trip ends in Zone 1 =		55	Σ of trip ends in Zone 2 =		125	Σ of trip ends in Zone 3 =		170	Σ of trip ends in Zone 4 =		200

1. "Forecasting Distribution of Interzonal Vehicular Trips by Approximations" by Thomas H. Fratar. Published in the Proceedings of the Highway Research Board, 33rd Annual Meeting, 1954, page 376.

$$\frac{\Sigma\ (t_D)}{\Sigma\ (t_D\ .\ F_O)}$$

where $\Sigma\ (t_D)$ is the accumulation of all of the trips that have an end in the destination zone and $\Sigma\ (t_D\ .\ F_O)$ is the accumulation of each trip that has an end in the destination zone multiplied by the growth factor of the zone situated at its opposite end.

The L factors, then, are area-wide factors in the sense that they require much more information to calculate than can be obtained from the two zones involved in the forecasting computation at any given instant.

The terms "O" and "D" as used in the above nomenclature are fictitious because the tabulated trips are between zones without regard to direction but if the reader will consider the left-hand zone number designation in Table IV for each trip entry as the origin and the right-hand zone number for each trip entry as the destination, no confusion will result. Also, the reader should note that F and L are factors that apply to a particular zone and take on subscripts of O or D only when a particular interzonal movement is being considered. Any F value that is an origin F for a particular movement is also a destination F for many other movements.

There are two other successive approximation methods of forecasting that were developed subsequent to the Fratar Method. They are: the Detroit Method[2] and the average factor method.

The formula for the Detroit method is:

$$t'_{O\text{-}D} = t_{O\text{-}D}\ \frac{(F_O\ .\ F_D)}{F_A}$$

The only new factor appearing in this formula that was not previously defined in the Fratar Method is F_A which is the over-all growth factor for the entire area under study.

The formula for the average factor method is:

$$t'_{O\text{-}D} = t_{O\text{-}D}\ \frac{(F_O\ +\ F_D)}{2}$$

All of the forecasting methods discussed thus far are called growth factor models. There is one other method in some use called the "gravity model" which utilizes multi-variable equations which usually take into account the distance between zones, automobile ownership and other factors. The determination of the parameters of the equation depends upon an analysis of the characteristics of the area under study.

The discussion presented thus far in this article is intended to furnish the reader with a perspective of the forecasting problem in general. The rest of the article will be devoted specifically to the electronic computational aspects of traffic forecasting.

Planning Computer Solution

When doing the preliminary planning for programming a traffic analysis problem for electronic computation, it is generally a good policy to analyze the job without a particular computer in mind. In other words, the computer should not be selected until the computational requirements of the job are well defined. Then an economic analysis of the problem should be made for the machine best suited for the job and another analysis for the machine customarily used at the engineer's place of work. In some cases, economics will dictate going outside the home installation and in others the home shop can do the job best. There are many factors to consider, such as outside machine availability, how often the program will be run, machine rental rates, availability of programmers, travel requirements, magnitude of the job and others, but generally speaking, it is not a good policy to assume that all work should be done at the local installation regardless of computational requirements.

In the subsequent discussion, such an analysis will be developed for traffic forecasting using the Fratar Method as an example.

For the Fratar Method, the various elements of the forecasting equation must be developed by the computer or supplied as input. Restating the Fratar Formula:

$$t'_{O\text{-}D} = t_{O\text{-}D}\ .\ F_O\ .\ F_D\ \frac{(L_O + L_D)}{2}$$

$t'_{O\text{-}D}$ is the expanded or forecasted trip value for any particular movement for any particular approximation and is the answer or an interim answer so it will be an output item. $t_{O\text{-}D}$ is the original zone-to-zone trip movement or the result of the previous approximation so it will be an input item. F_O and F_D are the zone growth factors which must be supplied as input for the first iteration but must be calculated for each succeeding approximation. In succeeding approximations, the growth factors converge toward a limiting value of one and at convergence, the job is finished.

$F = \frac{\Sigma T}{\Sigma t}$ where ΣT is the total number of future design year trips having ends in the zone in question. ΣT for any particular zone is a constant throughout the problem and will be supplied as input or initially calculated from $\Sigma T = \Sigma t\ .\ F$ where Σt is the total number of original or survey trip ends in the zone in question and F is the original zone growth factor.

The "location" factors (L) must be calculated from

$$L = \frac{\Sigma\ (t)}{\Sigma\ (t\ .\ F_D)}$$

Here, L and $\Sigma\ (t)$ refer to a particular zone and F_D refers to the growth factors of all of the zones in the system that have origins or destinations of trips connected to the particular zone.

There are then two types of input information, i.e., zone-to-zone trip information which will be called File A and zone growth factor and summations by zones of present and future trip end information which will be called File B. Usually the first item of interest in planning a computer problem is the input and output record volume. If the number of zones in the survey area is represented by n, reference to Table III will show that the File A record volume will be $\frac{n\ (n+1)}{2}$.

If the File A input is presented as shown in Table IV, the record volume will be $n\ (n+1)$. Actually these formulas will give record volumes higher than actual because some zone-to-zone movements will be zero and need not appear but they serve very well for estimating purposes. The choice of whether to use the input form shown in Table III or in Table IV depends on whether sufficient memory storage is available for storing intermediate results. It will be assumed that unrestricted storage is available at this point in the analysis, so that the form shown in Table III will be used.

2. Report on the Detroit Metropolitan Area Traffic Study, Part II, March 1956, J. D. Carroll, Jr., Study Director.

Table V
Memory storage requirements and calculated values for a hypothetical four zone system.

	Memory Area	Zone 1	Zone 2	Zone 3	Zone 4
F	1	1.00	2.00	3.00	4.00
Σt	2	55	125	170	200
ΣT	3A	55	250	510	800
$\Sigma(t_0 \times F_D)$	3B	155	340	495	625
L	3C	.355	.368	.343	.320

File B will have a much smaller record volume since each record contains only information about a particular zone rather than interzonal movements so File B will be composed of n records.

To do a complete forecasting job, the engineer is usually interested in design year traffic volumes for at least 3 modes of travel. Perhaps the choices would be passenger cars, trucks and mass transit. All three modes can be handled in one computer run if the policy of not making any machine restrictions at this point is followed. The processing of more than one mode will not increase the record volume of either File A or File B since the information for all three modes can be contained in a single record.

A good computer program must be quite general to accommodate a wide range of situations. The larger urban areas frequently have as many as 500 traffic zones. To be universally useful the program should accommodate at least this number. This will result in a possible File A volume of 500 (500+1) = 125,250 records, and a File B volume of 500 records.

The next point of interest is memory storage requirements. Again using the four-zone example, the memory requirements for data storage would be as shown in Table V.

Computational Procedure

Σt (summation of present trip ends) in memory area 2 is filled by processing File A and accumulating each trip value at both the origin and destination zones. Notice that these values match those at the bottom of Table IV and have been obtained by processing one-half the record volume shown in Table IV.

Area 1 is filled in either of two ways:

a. The growth factors are supplied as input and read into area 1.
b. The growth factors are computed from $\Sigma T \div \Sigma t$, that is, area 3A by area 2.

Area 3A may now be computed by:

a. Multiplying area 2 by area 1.
b. If area 1 is not supplied as input, area 3A is filled from reported input.

Area 3A may now be written-out for temporary external storage leaving the B area open to receive $\Sigma (t \cdot F_D)$. The original File A must now be processed a second time. Each trip value is multiplied by the destination zone growth factor and accumulated at the origin zone in memory area 3B; then the same trip value is multiplied by the origin zone growth factor and accumulated at the destination zone in area 3B.

After File A has been processed the second time, then the location factors may be computed by dividing memory area 2 by area 3B. The result may be stored in the same location just occupied by 3B to become 3C.

All of the elements of the basic forecasting equation have now been obtained or calculated with the exception of the trip values which will be obtained from the original File A. As each record is read into the machine (this is the third processing of the zone-to-zone movements) the trip value is multiplied by the origin growth factor, the destination growth factor and the average of the origin and destination L factors. The result is accumulated in memory area 2 at both the origin and destination zones and also replaces the trip value in the File A record. The record is then written out to become a part of a new expanded File A.

When File A has been completely processed the third time and memory area 2 is filled with its second set of values, area 3A is again filled with ΣT which is read in from external storage. A new set of F values may now be computed by dividing area 3 by area 2 and the result stored in area 1.

One approximation, has now been completed. It is now necessary to obtain some index of convergence. This may be done by computing a frequency distribution of growth factors and printing it with a typewriter or "on-line" printer so that the engineer may decide whether to continue for another approximation. Since $F = \frac{\Sigma (T)}{\Sigma (t)}$, when the zone growth factors have reached a value of one, the expanded trip ends in each zone match the forecasted trip ends and all of the movements are in balance.

To continue with the second approximation, the new expanded File A is processed to fill area 3B as before. New L factors are calculated and the new File A processed a second time to fill area 2 and create a new File A. New growth factors are then calculated and the frequency distribution printed. This concludes the second approximation. The process may be repeated as often as the engineer may require. Usually three approximations are sufficient. A general flow chart is shown in Figure 3.

Table V shows that three memory storage areas are required. Each area requires one storage field per zone. Using the example of 500 zones, 1500 fields are required per mode of travel or 4500 for three modes. This is exclusive of the memory storage for the program and other minor data storage.

It should be noted that File A must be processed three times for the first iteration and twice for each iteration thereafter. Assuming three iterations as being sufficient, File A or modifications of it, is read seven times. With 125,250 possible zone-to-zone movements, a total of 876,750 possible records containing three modes each would have to be read. For each approximation there is a new File A written, so for three approximations, this amounts to 375,750 possible records of output. If because of machine restrictions, only one mode could be processed at a time, the input record volume would amount to 2,630,250 possible records and the output would be 1,127,250 possible records for all three runs. If further restrictions on storage capacity are such that a square input is required as shown in Table IV, the possible record totals amount to 5,260,500 input and 2,254,500 output.

Summary

Traffic forecasting is definitely in the data processing class, when using the approach described above as opposed to so-called scientific problems that have limited input and output. Ideally,

(Continued on page 54)

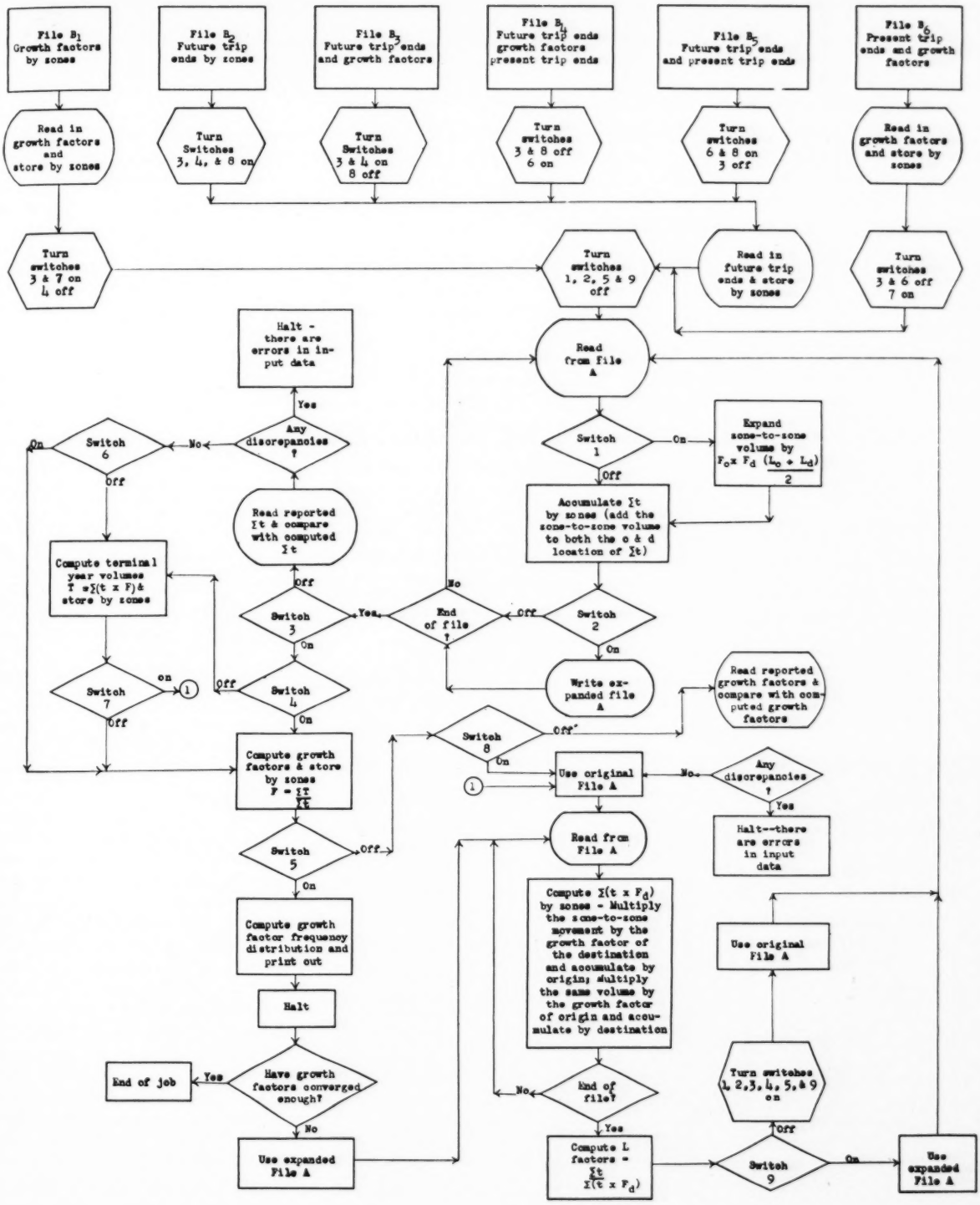

File B1 Growth factors by zones
File B2 Future trip ends by zones
File B3 Future trip ends and growth factors
File B4 Future trip ends growth factors present trip ends
File B5 Future trip ends and present trip ends
File B6 Present trip ends and growth factors
Read in growth factors and store by zones
Turn Switches 3, 4, & 8 on
Turn Switches 3 & 4 on 8 off
Turn switches 3 & 8 off 6 on
Turn switches 6 & 8 on 3 off
Read in growth factors and store by zones
Turn switches 3 & 7 on 4 off
Turn switches 1, 2, 5 & 9 off
Read in future trip ends & store by zones
Turn switches 3 & 6 off 7 on
Halt - there are errors in input data
Read from file A
Yes
Any discrepancies ?
No
Switch 6
On
Off
Switch 1
On
Off
Expand zone-to-zone volume by $F_o \times F_d \frac{(L_o + L_d)}{2}$
Read reported Σt & compare with computed Σt
Accumulate Σt by zones (add the zone-to-zone volume to both the o & d location of Σt)
Compute terminal year volumes T = Σ(t x F) & store by zones
Off
Switch 3
Yes
End of file ?
No
Off
Switch 2
On
Switch 7
on
1
Off
Switch 4
Off
On
Write expanded file A
Read reported growth factors & compare with computed growth factors
Compute growth factors & store by zones $F = \frac{\Sigma T}{\Sigma t}$
Switch 8
Off
On
1
Use original File A
No
Any discrepancies ?
Yes
Halt--there are errors in input data
Switch 5
Off
On
Read from File A
Compute Σ(t x F_d) by zones - Multiply the zone-to-zone movement by the growth factor of the destination and accumulate by origin; multiply the same volume by the growth factor of origin and accumulate by destination
Use original File A
Compute growth factor frequency distribution and print out
Halt
End of job
Yes
Have growth factors converged enough?
No
End of file?
No
Yes
Turn switches 1, 2, 3, 4, 5, & 9 on
Off
Use expanded File A
Compute L factors = $\frac{\Sigma t}{\Sigma(t \times F_d)}$
Switch 9
On
Use expanded File A

Figure 3
General logic flow chart for programming the Fratar forecasting method for an electronic computer.

Traffic News

Pedestrian Malls Hit by Gruen

Victor Gruen, architect and planner, criticizes pedestrian mall experiments in a recent article in *National Civic Review*. He says:

"The trouble with these mall experiments is that they are not based at all on planning considerations. They are rather the result of promotional and advertising mentality, with the aim of creating sensations, and are quite similar to other downtown promotional activities like dollar days, parades, etc. The creation of pedestrian areas downtown can be successful only if it is accomplished as an integral part of an over-all plan. In fact it is probably one of the last measures for implementation within a carefully scheduled revitalization plan, and it just cannot be the beginning.

Only after proper access from suburban areas toward the central business district has been achieved for private as well as public transportation, only after a belt road system around the downtown core together with directly adjoining terminal facilities for public transportation and storage facilities for private cars has been constructed, only after a system for servicing downtown buildings has been implemented, can the creation of pedestrians districts be accomplished.

The replacement of the choking ring of slums which we find around most of our downtown cores by new high density residential areas is another prerequisite to the improvement of the environmental qualities of the downtown core, of which the pedestrian island concept is a part.

The trouble with the mall experiments (including the permanent one in Kalamazoo which, in fact, was part of the over-all plan which our office developed for that city) is that they are spatially limited, poorly executed, promotional measures based on a complete misunderstanding of the whole problem. They are the direct outcome of the desire which most downtown interests share to do quickly and cheaply something spectacular and to rely on patent medicines rather than a thorough treatment.

The downtown mall experiments are only another measure in the endless series of single, unrelated measures like one-way streets, municipal garages and parking lots, scramble crossings, spot redevelopment, new street lighting and all the other gimmicks which are so popular because they create for a time a certain amount of excitement and can be implemented without the investment of too much brain-power or too much money.

Only if we recognize that the urban crisis, which is the outcome of deep-seated disease which has progressed for 50 years, cannot be cured by administering aspirin in the form of unrelated small measures, but that an over-all treatment based on a clear understanding of the problems is needed, will we be successful in revitalizing our cities.

Only if we are willing to accept the automobile for what it is—a servant to mankind and not a deity; only if we are willing to progress in a civilized manner, enlarging our concepts concerning the separation of incompatible uses; only then will we be able to live up to the challenge of the sixties and create superior cities of truly human environmental qualities for the dramatically increasing urban population."

Chicago's Edgewater Beach Hotel (indicated by arrow) is to be the site of the 30th Annual Meeting of the Institute of Traffic Engineers, September 12-15, 1960. With its 1,000 guest rooms and splendid social and recreational facilities, the hotel is a self-contained resort only 20 minutes away from the Loop via Lake Shore Drive or rapid transit. Lake Michigan, bordered by miles of sandy beaches and beautiful parks, is in the upper left corner. Plan to make reservations early.

Interstate System Has 7570 Miles Completed, Says BPR

As of January 1, 1960, there were 7,570 miles of the 41,000-mile National system of Interstate and Defense Highways open to traffic. The status of the system was compiled by the Bureau of Public Roads, U. S. Department of Commerce, from reports received from its field offices in 48 States and the District of Columbia.

Of the 7,570 miles in use, 2,790 were completed to full or acceptable standards for 1975 traffic and 2,520 were adequate for present traffic but will need additional improvement to bring them up to those standards. The 7,570 miles also include 2,260 miles of toll roads, bridges, and tunnels incorporated into the Interstate System, as permitted by law.

Of the mileage open to travel, 3,360 miles were built or improved with Federal funds authorized to complete the Interstate System, most of which has been on a 90 per cent Federal, 10

TABLE I

Mileage improved and open to traffic		7,570
Completed to full or acceptable standards	2,790	
With Interstate funds	2,220	
With other public funds	570	
Improved to standards adequate for present traffic but additional improvement needed to meet full or acceptable standards	2,520	
With Interstate funds	1,140	
With other public funds	1,380	
Toll facilities	2,260	
Mileage under construction with Interstate funds		4,770
Preliminary engineering or right-of-way acquisition		18,370
Total mileage improved or work under way		30,710
Additional designated mileage		9,910
Mileage not designated		380
Total Interstate System mileage authorized		41,000

per cent state share basis. The remaining 4,210 miles had been built or started by the states, public authorities, and localities before 1956 under other programs—in many cases with Federal financial aid in some amount.

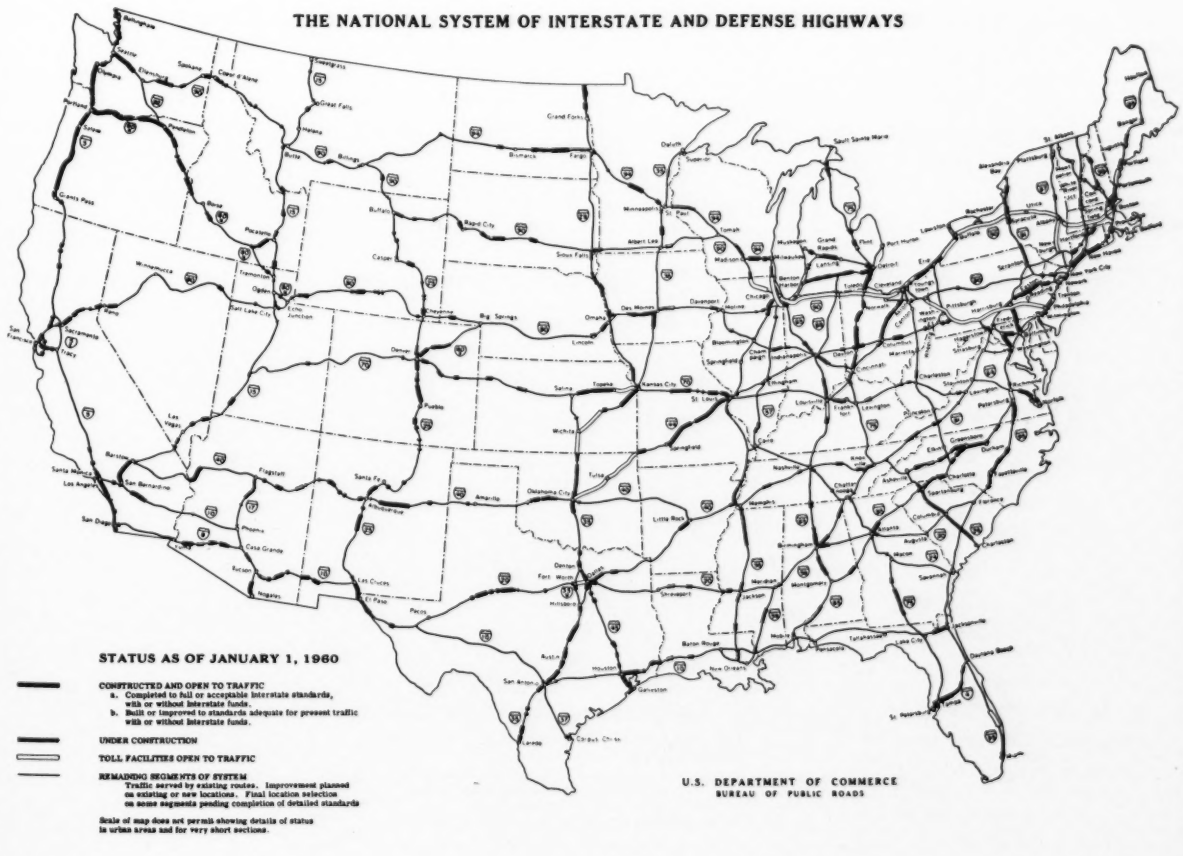
In addition to sections open to traffic, 4,770 miles were under construction with Interstate funds, and preliminary engineering or right-of-way acquisition was in progress on another 18,370 miles. Thus, of the total of 41,000 miles, some form of work was completed or under way on 30,710 miles.

The status of the Interstate System as of January 1, 1960 is summarized in Table 1.

Legislation Offered For Washington Transportation Plan

Legislation to help solve Washington's transportation problems was submitted to Congress on March 10 by the Bureau of the Budget, at the request of President Eisenhower.

The report of the National Capital Planning Commission and the National Capital Regional Planning Council, *Transportation Plan—National Capital Region*, authorized by Congress in 1955 and completed in July 1959, concluded that a coordinated transportation system of rail transit, express buses, and highways is urgently needed to meet the growing transportation problems of the District of Columbia and the surrounding metropolitan area. Such a system would permit the more effective performance of the functions of the Government, preserve the beauty and dignity of Washington as the nation's capital and promote the welfare and economy of the entire region, which is increasing in population at


THE NATIONAL SYSTEM OF INTERSTATE AND DEFENSE HIGHWAYS
STATUS AS OF JANUARY 1, 1960
CONSTRUCTED AND OPEN TO TRAFFIC
a. Completed to full or acceptable Interstate standards, with or without Interstate funds.
b. Built or improved to standards adequate for present traffic with or without Interstate funds.
UNDER CONSTRUCTION
TOLL FACILITIES OPEN TO TRAFFIC
REMAINING SEGMENTS OF SYSTEM
Traffic served by existing routes. Improvement planned on existing or new locations. Final location selection on some segments pending completion of detailed standards
Scale of map does not permit showing details of status in urban areas and for very short sections.
U.S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS

one of the highest rates in any of the nation's metropolitan areas. The probable alternative to such action appears to be construction of a greater number of highways leading into the city, diversion of large downtown areas of the District of Columbia to parking for private automobiles, and increases in time devoted to traveling to and from work.

In his letter of transmittal, the Director of the Budget Bureau says:

"As a consequence of this review the present proposal conforms substantially with regional views in such important respects as coordination and conformity to local land use plans and codes; local representation on the Federal organization's advisory board; limitations on the Federal organization's condemnation powers in the states and support of an interstate compact agency which would be encouraged to take over the functions of the Federal agency. Some of the devices proposed to insure coordination with local and state governments and to encourage creation of an interstate body to deal with the transit problem may well prove to be precedents having utility in meeting other Washington metropolitan area problems."

The proposed legislation provides for (1) creation of a temporary National Capital Transportation Agency, (2) authorizes negotiation of a compact setting up an interstate proprietary agency, and (3) if necessary, the later creation of a Federal transportation corporation.

The National Capital Transportation Agency would be headed by an administrator and an advisory board, the majority of whom would be residents of the national capital region. The agency would have various functions, mainly of a non-revenue-producing nature. Those would include preparation of a comprehensive up-to-date transit development program, consisting of plans, proposed routes and locations for the transportation of persons in the region, together with a timetable for the provision of facilities and financial estimates of costs and revenues. The program would conform, to the extent practicable, to the general plan for the development of the national capital region and to the comprehensive plan for the national capital prepared by the National Capital Planning Commission and the National Capital Regional Planning Council. Before carrying out any aspects of the transit development program, the agency would submit it for review and comment to the local governing bodies and other appropriate groups in the region. The program would also be submitted to the governors of Maryland and Virginia or to such state or local agency as each may designate for review and approval before any activities would be carried on in their states.

Subject to this review and approval the agency, which would be financed by direct appropriations, would have authority to complete necessary planning and engineering for a comprehensive rail-bus system, acquire rights-of-way and build bus stops on freeways, acquire and operate outlying parking facilities for transit users, and work with railroads to improve commuter services. The agency would have no power to acquire private transit companies, operate buses or other motor vehicles or provide for their operation. In the first three years (fiscal years 1961 through 1963) an estimated $20 to $25 million in appropriations may be required for these purposes. If it proves feasible to begin construction of a subway line in 1963, an additional $30 million in appropriations may be needed at that time.

On or after July 1, 1963, the President would be authorized to abolish the agency and create a National Capital Transportation Corporation. Before establishing the corporation, the President would give due regard to progress being made in negotiation of the proposed interstate proprietary compact. If the compact has been agreed to or its negotiation appears likely, the corporation would not be created. The corporation would be given the powers of the agency and in addition, subject to local coordination and review, would have full acquisition and operating powers as a Federal business enterprise to improve transit services in the region. It would take over the assets and funds of the agency. The corporation would have authority to set fares and other charges for the services rendered by its facilities and could provide for operation of such transit facilities or, if necessary, operate them directly. Both the statement of purpose and specific provisions of the bill place emphasis on the greatest possible use of private facilities, both to minimize Federal investment and to take advantage of the skills and experience acquired over the years by well developed private transit systems.

To finance its activities, the corporation would be authorized to obtain funds both from appropriations and by borrowing from the Treasury Department amounts authorized in appropriation acts. On the basis of preliminary estimates and allowing for interest on borrowings prior to completion of the first major stage of development, by the end of 1968 the corporation and its predecessor agency may require a total of $265 million,

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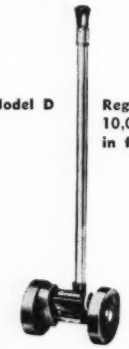

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half of which would be from appropriated funds and half from borrowed funds.

The corporation's funds would be used to: (1) complete most of the detailed planning and construction engineering plans for the subway transit system; (2) build express bus stops and parking sites for transit users; (3) provide for expanded bus service, if necessary; (4) acquire rights-of-way, including wide median strips in new freeways for buses and trains; and (5) construct one of the four major rail transit lines. A subway line could be built from the District line in the northwest across the downtown area, for example, to connect at the Union Station with the existing private railroads.

The Budget Bureau concludes:

"The net result would be the creation of a reasonably comprehensive and workable transit system which meets the needs of the national capital region in 1968. The estimated revenues for such a system are expected to be adequate in 1969 to cover all operating costs, including interest on borrowings from the Treasury. If the interstate proprietary agency by this time is not yet ready to assume the corporation's functions, the corporation could come back to the Congress for increased appropriations and borrowing authority necessary to complete the rapid rail transit system over the following decade.

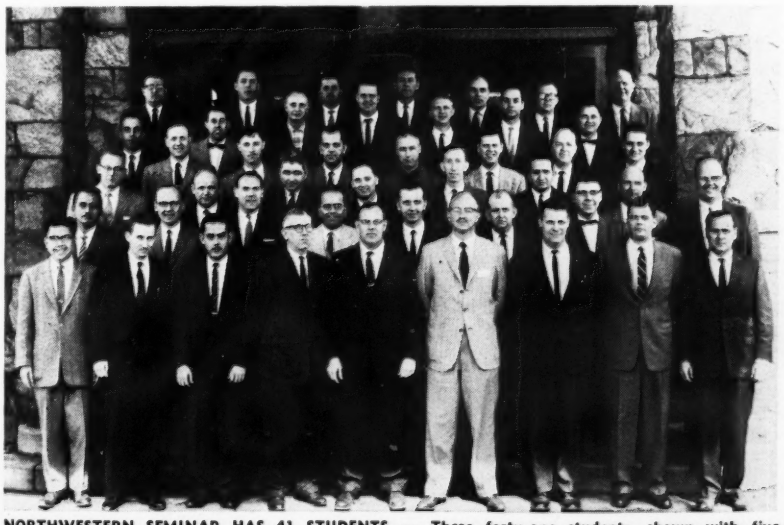
"Finally, this proposed legislation would authorize negotiation of a compact to create an interstate proprietary agency to carry out the objectives of this legislation. Such an interstate compact might create an agency similar to the Port of New York Authority or set up a regional organization controlled by the local governing bodies of the national capital region. Upon approval of the compact, the President would submit to Congress recommendations for transferring the Federal agency's or corporation's functions and such assets and liabilities as are determined to be appropriate."

Mickle to Represent ITE at Pan American Highway Congress

D. Grant Mickle, former president of the Institute of Traffic Engineers and director of traffic engineering for the Automotive Safety Foundation, has been named to represent the Institute at the 8th Pan American Highway Congress.

The designation of Mr. Mickle by President Wetzel followed official invitations from the Organization of American States (Pan American Union) and the U. S. State Department for the Institute to be represented at the Bogota meeting in May.

Mr. Mickle represented ITE at the previous conference held in Panama in 1957. This year he will be a member again of the official U.S. delegation, which will probably include (as in 1957) a number of Institute members.



NORTHWESTERN SEMINAR HAS 41 STUDENTS — These forty-one students, shown with five instructors, completed on March 25 an intensive three-week traffic engineering seminar at the Traffic Institute, Northwestern University, Evanston, Ill. The seminar was presented by the Traffic Institute in cooperation with the Midwest Section, Institute of Traffic Engineers. Shown in (left to right) Row 1 are Fred Lee, Edward Laks, Noel Lopez, Carlton Swaim, William Wright, Paul Frederiksen, Albert Thomas, Jr., Alexander Harvey, and Charles Goldsmith; Row 2: Juan Vazquez-Rodas, Raynold Folland, Thomas Dalton, Jr., Mervil Miller, Jr., James Pryer, O. J. Reichelderfer, Jr., Jean Keneipp (instructor), and Glenn V. Carmichael (instructor); Row 3: Richard Leuttich, William Magee, Edward O'Malley, Norman Nelson, Peter Froggatt, Charles Alexander, and Alan Tate; Row 4: Frank Hawley, Hugh Yeomans, Walter Swiderski, Raymond Monteleone, Donald Morgan, Charles Powell, and Kenneth Dietz; Row 5: Jack A. Hutter (instructor), Herbert Burnham, Jr., Hadley Nation, Raymond Pusey, George Timbert, Charles Gordon, Bruce Trant, and Row 6: Michael A. Powills (instructor), George Guthrie, Jr., Frank Lane, John Forrest, Frederick Pirie, William Gerstle, Jr., and George Larsen (instructor).

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MISSISSIPPI STATE UNIVERSITY SPONSORS SHORT COURSE—A short course in traffic operations was held late in March at Mississippi State University under the direction of Professor O. K. Anderson of the Department of Civil Engineering. Pictured above (l. to r.) are two students and three instructors, Arthur M. White, Mississippi State Highway Department, C. C. Robinson, Automotive Safety Foundation, and Webb J. Crecink, also of the State Highway Department.

Tolls and Higher Parking Fees Suggested

A recommendation to discourage the use of private automobiles in cities and to divert more commuter business to mass transit systems, by charging tolls on city expressways and increasing community parking fees is included in a Commerce Department report on Federal Transportation Policy and Program that the White House has sent to Congress. The report points out that these proposed increased charges on highway users might be used "to pay for other transport facilities."

In urging that "basic approaches" to solving the urban transportation problem be investigated, the report states:

"Methods might include amendment of existing highway legislation to allow charges on city highway gateways to help divert auto commuter travel to mass transport means, higher community parking fees to help similarly, diversion of such funds to pay for other transport facilities, etc."

Secretary of Commerce Mueller, in a statement accompanying the report, said that "increasing reliance on private enterprise and lessening dependence on government action is emphasized throughout the report."

He added: "The object is free choice by the public to select the mode of transport that best suits its needs but with protection against both monopoly abuses and destructive competition. The recommendations seek to free our railroads, trucking, airlines and marine industries from obstacles that hinder them from keeping pace with America's growing economy and from contributing their maximum effort to such growth. Gradualism is the key to realistic and effective methods for making necessary changes in transportation to avoid abrupt adjustments and consequent possible injury to the public interest. The recommendations outline a step-by-step advance—assuring sound, steady progress towards better, safer and more economical transportation for all Americans."

The report contains 78 recommendations to meet the "pressing need" for major improvements in the nation's transportation system that will provide the best possible service at the lowest reasonable cost to the public.

Among the recommendations are the following:

Uniformity of state regulation with respect to sizes, weights, safety appliances, and related matters of highway vehicles operating in interstate commerce, is of interest to the Federal Government in view of its effect upon the manner in which interstate highway transportation may be conducted. Accordingly, the states should be urged to move rapidly towards uniform legislation in these matters.

The remaining Federal excise on commercial passenger transportation should be repealed when the budget requirements allow, and when tax reform is considered.

Trucks . . . should be relieved of unnecessary curbs. These curbs include route restrictions, restrictions that prevent common and contract carriers from servicing all points within their authorized territories, commodity restrictions and restrictions on the type of service provided.

All forms of transportation should "organize, staff and finance a special task force to explore the practical applications of modern mathematical and electronic techniques as a basis for improved cost finding."

The Government should establish a transport investment planning staff to use objective analytical methods in making unified, long-range Federal investment plans to be published and included in the annual budget document.

Appoint advisory groups of users to make recommendations on the engineering and economic feasibility of Federal investment programs.

Railroads and buses should have considerable freedom in adjusting passenger fares to try to retain passenger traffic and otherwise minimize deficits.

Where inequality in the tax treatment accorded different forms of transportation "is the result of Federal tax policy, such policy should be altered to romove it. Where it is the result of tax policies at other levels of government, the Federal Government may reasonably undertake thorough study of the effects upon transportation policy and development and encourage review and revision."

Highway Lighting Needs Re-evaluated By Blackwell

The amount of light needed for safe driving at night may be twice what has until now been considered sufficient according to a recent paper at the Illuminating Engineering Research Institute's Symposium in Washington.

Reporting on not-yet-completed studies, Dr. H. Richard Blackwell, director of Ohio State University's Institute for Research in Vision (Columbus), indicated that recommended practice in highway lighting may be 50

per cent below the level needed for safely stopping a vehicle moving at 40 or 45 miles an hour. Recommended practice is 0.2 to 1.2 footcandles. Dr. Blackwell's measurements, using a new version of his evaluator, which is generally recognized as one of the most dependable instruments in illuminating engineering, show a need for 0.7 to 2.8 footcandles.

Additionally, the curb lane — the lane which pedestrians enter when stepping from the sidewalk — requires about twice as much light for relative safety as the center or driving lanes, Dr. Blackwell said.

Benjamin S. Pritchard, also of Ohio State University, in a paper that Dr. Blackwell read in his colleague's absence, reported new findings on sight through fog on turnpikes. Three-hundred-watt spotlights, mounted on 28-foot poles so that their beams are directed away from the driver's line of sight at an angle of approximately 40 degrees from the perpendicular, Pritchard found, can produce safe visibility up to 136 feet in a fog which, in daytime, would reduce visibility to a scant 60 feet.

Dr. Blackwell, who two years ago developed a system for predicting the lighting needs of indoor seeing tasks, recently adapted his method for use on outdoor tasks. Initial use of this development has been in roadway and highway lighting studies in Columbus, Cincinnati, Dayton and other cities in Ohio and elsewhere. In these tests Dr. Blackwell used a mannequin, approximating the stature of an 11-year-old girl, and life-size models of black and white terriers. In some instances he also dropped other obstacles, such as bricks, tin cans and simulated "holes in the road" into his field of view to heighten the realism of his results up to 200 feet away from his observation post.

While further studies must be made, Dr. Blackwell reported, results thus far have helped to clarify several technical testing problems. Perhaps most significant among these is that the contrasts in the viewing task—namely the mannequin and the dogs against the background of the road—vary sharply with relatively minor displacement between luminaires spaced 100 feet apart on alternate sides of the road.

"We have not satisfactorily cracked this tough nut," Dr. Blackwell said, "but we expect that we shall. In the meantime we believe we can safely say that recent special lighting installations, such as those being made on busiest downtown shopping streets, which deliver up to 2.8 footcandles, are about right."

Since 1.2 footcandles is the top of the range published in current recommended practice for highways, the amount of light now found on most illuminated roadways and highways at night should be at least doubled to attain the degree of safety recognized as practical in the Blackwell tests. Furthermore, since research has shown that curb lanes require twice as much illumination as driving lanes, lighting in some instances should be quadrupled to meet this safety level.

Pritchard, the second Ohio State man on roadway lighting, was among three researchers who furthered sight-through-fog work up to about three years ago at the Pennsylvania State University and the University of Michigan after developing artificial fog with the same optical properties as natural fog. They were pioneers in measuring the visual results when fog was struck by beams of light at various angles. Present work at O.S.U. is an extension of the studies at Pennsylvania which were originally conducted in a 50-foot Army medical tent. To improve consistency of control, Pritchard miniaturized the study, simulating three lanes of a six-lane section of the New Jersey Turnpike on a scale one-eighth actual size in a 32-foot box eight feet wide and five feet deep.

A car model less than two feet long, arranged so that it could be moved readily by remote control to points various distances from the observer's station, was used as the target. The car was equipped with headlights and tail lights with beams scaled to appropriate intensities, with shiny bumpers and with a body finish in white and blue to offer both light and darker areas for observation purposes.

To simulate the headlamps on the observer's car, a set of lights also was mounted in a stationary position below the glass window of the observer's post.

Fog was introduced into the box by forcing water and compressed air through four fine nozzles mounted at the sides. Each nozzle was controlled by a regulator, and the density of the fog was monitored by a specially-built instrument called a "transmissometer" through which an accurate testing condition could be maintained.

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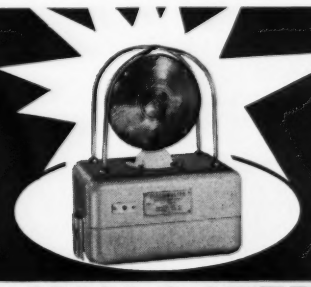

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1959 PROCEEDINGS

29th Annual Meeting, Institute of Traffic Engineers

The PROCEEDINGS of the 1959 meeting of the Institute of Traffic Engineers, held in New York City in September 1959, has just come off the press. Containing all principal papers presented at the meeting, this volume will be of interest to traffic engineers, traffic administrators, enforcement officials, planners, students, teachers, libraries and others. 271 pages, 6 x 9, illustrated. Price, $2.00.

Contents

Transportation Progress in Perspective, *T. T. Wiley*

Theodore M. Matson Citation

Highway Safety, *Charles W. Prisk*

A Comparison of Vehicle Operating Characteristics Between Parallel Lane and Direct Taper Types of Freeway Off-Ramps, *Robert D. Conklin*

Space Age City Traffic, *S. S. Taylor*

Operational and Planning Aspects of Urban Trafficways, *Robert Van Hoef*

The State Highway Department's Responsibility for Urban Express Highways, *Rex M. Whitton*

Coordinated Development of an Interstate Facility, *Edward S. Olcott*

Progress and Current Activity on Uniformity of Traffic Control Devices, *Wilbur S. Smith*

Improvements in Traffic Laws and Ordinances Necessary to Meet the Needs of Traffic Operations on the Interstate System, *John H. Mitton*

New Developments in the Field of Roadway Lighting, *Charles H. Rex*

The Professional Responsibility of City Planners and Traffic Engineers in Urban Transportation, *Alan M. Voorhees*

Findings of ITE Membership Survey, *W. L. Carson*

Urban Transportation Administration, *Thomas J. Seburn*

Scope of Examinations and Prerequisites for City Traffic Engineering Positions, *Edward M. Hall*

School Crossing Protection, *Robert D. Dier*

Yield Right-of-Way Signs: Warrants and Applications, *James H. Kell*

Warrants for Four-Way Stop Signs, *Harold Marks*

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Ramp Terminal Channelization, *Maynard Glass*

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Planning Criteria for Urban Traffic Ways, *David. W. Schoppert*

Operating Costs of Parking Facilities, *Eugene A. Barton*

Facilities for Express Bus Operation on Freeways, *William R. McConochie*

Planning and Design of Airport Terminal Parking Facilities, *Robert W. Harris and Charles S. Michalski*

Pedestrian Signal Problems, *Marble J. Hensley*

Standards for External and Internal Illumination of Traffic Signs, *Richard I. Strickland and Irwin Hart*

Sign Supports—Characteristics, Materials, Design, Criteria and Costs, *William F. Bauch, Jr., George M. Webb and Wayne N. Volk*

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Two separate lighting systems were installed in the box. One set simulated the four eight-foot fluorescent lamps, each with a special cylindrical reflector, mounted three feet above the median strip at an experimental section of the Turnpike. These lamps were intended to floodlight the roadway without emitting any light above the horizontal. The second set simulated 16 300-watt lamps mounted on 28-foot poles above the median strip of the Turnpike. Each light had a simulated peak intensity of 30,000 candles.

All car headlights were adjusted by inserting a glass disc on which "fish-scale prisms" were mounted by hand in such a way that light could be placed precisely where it should be according to the manufacturer's specifications covering the lamp.

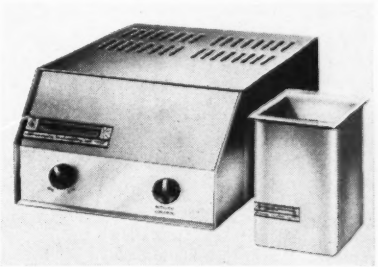
Charles R. Marsh, associate professor of electrical engineering at the Pennsylvania State University, established in his earlier IERI experiments there that fog could be penetrated — and visibility increased by at least 100 per cent — if roadway lights (either overhead or along the shoulder of the road) were so mounted that their beams were as perpendicular as possible to the driver's line of sight rather than parallel to that line.

In his simulation studies at Ohio State, Pritchard found that greater visibility through fog was achieved if the beams from roadway lighting installations were angled somewhat forward from the perpendicular and away from the observer's view. Without seriously increasing the amount of "scattered light" — which is least when beams are perpendicular to the pavement—the forward angle of the roadway lamps serves to illuminate the car ahead.

Pritchard also determined that taillights were most readily visible without roadlights of any kind. For seeing the car itself, however, whether or not it had a shiny bumper, special roadway lights were of considerable help. Additionally he found that the low-mounted roadlights were better for seeing the shiny bumper of the car ahead than were the overhead lamps—but that the latter were superior for seeing the body of the car.

The researcher further established that aiming roadlamps about 40 degrees forward from the perpendicular provided most car-body illumination at least cost in back-scatter from the fog.

Strictly Business



Ultrasonic Cleaner For Parking Meters And Signal Timers

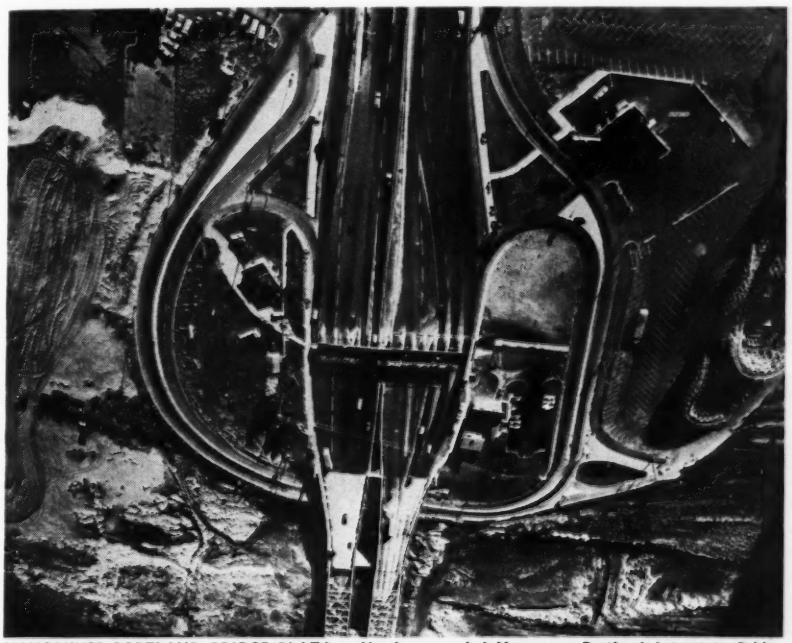
An ultrasonic cleaner for less than $100 offers interesting new possibilities for cleaning the timing mechanisms of parking meters and mechanical parts of signal controllers. The device, called the "diSONtegrator System Forty" by its manufacturer, Ultrasonic Industries, Inc., of Albertson, L. I., N. Y., sells for $99.95.

The System Forty, a full half-gallon capacity model, is the lowest priced ultrasonic cleaner available anywhere in the world. It compares in power, cleaning tank capacity, performance and appearance with other ultrasonic cleaners now selling for up to ten times the price.

According to Paul M. Platzman, president of UI, "The low price of the diSONtegrator will now enable any city or small establishment operating on a tight or limited budget to take full advantage of ultrasonic cleaning—the fastest, highest quality method of soil disintegration ever devised. Savings at the manufacturing and sales levels made possible by economies coincident with mass movement of merchandise are being passed on to our customers."

The System Forty will disintegrate more than fifty distinct classes of soils and contaminants in seconds from virtually thousands of different products ranging from surgical instruments, watches, clocks and false teeth to highly complex electronic components used in satellites and missiles.

The System Forty includes the Model G-40C1, a powerful 40-watt generator with an output of 90,000 cycles per second—the ideal frequency for small parts cleaning. The cabinet measures 10″L. x 8″W. x 5¾″H. and features only one control knob—a simple push-pull activity regulation throttle. The diSONtegrator System Forty ultrasonic cleaner consumes no more current than an ordinary light bulb.



VANCOUVER-PORTLAND BRIDGE PLAZA — Newly expanded Vancouver-Portland Interstate Bridge speeds 36,000 vehicles per day across the Columbia River on U.S. Highway 99. Fourteen-lane toll plaza features new vehicle classification and automatic toll collection systems designed and built by Taller Cooper Division of American Electronics, Inc., Brooklyn, N. Y. Revenue control system also provides for handling of credit card customers, furnishes receipts on request, and documents transactions on both printed record and punched tape.

NEW! Chemical Compound

VerPex

REMOVES TRAFFIC LINES

WILL NOT HARM ASPHALT, CONCRETE or BRICK PAVEMENT

REMOVES REFLECTIVE SHEETING

AND ALL KNOWN PAINTS FROM TRAFFIC SIGNS WITHOUT HARM TO ALUMINUM OR STEEL

EASY TO USE!

VerPex CAN BE SPRAYED, ROLLED or POURED ON FINISH TO BE REMOVED.

FAST ACTING!

IN FROM 5 to 15 MINUTES MOST PAINT FINISHES CAN BE BRUSHED OR FLUSHED AWAY.

NON-INFLAMMABLE! NON-FREEZING!

New VerPex is a non-inflammable solvent with low vapor toxicity, it is fast acting, non-corrosive.

New VerPex is not alone dependent on its solvent action but actually lessens the adhesion of paint to the surface by dissolving certain resins and oils in paint *as well as permeating remaining pigmentation*, making it easy to remove by scraping, brushng or flushing.

VerPex efficiently strips latex and the new epoxy resin paints.

VerPex contains:

- **a thickener which gives sufficient viscosity so VerPex stays in place when applied — important when applied to vertical or rounded surfaces.**
- **an evaporation retarder which prevents the solvent from escaping in to the atmosphere and keeps the solvent in the solution actively working on the paint to be removed.**
- **a non-inflammable synergist to aid in the solvency assuring quicker, deeper and more efficient removability.**
- **an inhibitor to prevent chemical reaction on various metals.**

If Your Distributor Cannot Supply You Drop A Card To —

VerPex CORPORATION

1275 MAIN AVE., N.W. • CLEVELAND 13, OHIO

The generator powers an amply sized half-gallon capacity cleaning tank, Model T-40C1, with working compartment measuring 5¾″L. x 5¼″W. x 4″D. The over-all dimensions are: 6¾″L. x 6¼″W. x 6½″H. The tank is heavy gauge stainless steel deep drawn with rounded corners. It is finished with a 4A grade high polish to avoid soil entrapment in crevices or corners, thereby assuring surgical cleanliness.

Operation is as simple as that of a radio; the generator is plugged into any convenient source of 117-volt 50/60 cycle current. Cleaning begins as soon as the tank is filled with a suitable cleaning solution such as solvent or water and detergent and the switch is flipped on. With the tank is a transducer which converts electrical energy from the generator into sound waves of such high frequency that human ears can't hear them. When ultrasonic energy is propagated in a cleaning solution, the fluid is exploded 90,000 times per second into millions of submicroscopic vacuum bubbles. This bubble bombardment disintegrates injurious soils clinging to the object to be cleaned. Complete precision cleaning of all types of soils is achieved, not only on the surface, but in the smallest, hard-to-reach crevices, in a matter of seconds. Intricate parts can be cleaned without disassembly.

Both generator cabinet and transducer tank housing come in six attractive decorator colors to harmonize with laboratory, office, store or plant color schemes. At no extra charge, a choice of turquoise, ivory, wheat yellow, soft grey, pale green and desert sand are available.

The UI diSONtegrator is backed by a free five-year service contract and a two-year parts guarantee, the most complete coverage available anywhere.

Contest Brings Out Wit and Wisdom of Highway "Language"

Twelve of 35 winning entries in a nationwide Unusual Traffic Signs contest among traffic engineers are pictured in the accompanying photographic collection. Winning signs form the nucleus of a Museum of Unusual Traffic Signs, set up as part of the Cataphote Institute of Traffic Psychology, by the Cataphote Corporation of Toledo, Ohio, Jackson, Miss., and Brantford, Ont.

From the Museum of Unusual Traffic Signs, Catophote Institute of Traffic Psychology

1. "Cree Indian Word for 'Whoa' "—Highway #2, near Hobbema Indian Reserve, Alberta, Canada. Submitted by D. D. Kuchinski, Traffic Safety Engineer, Dept. of Highways, Province of Alberta, Canada.
2. "Parking Limit 15 Days"—M-20 in Michigan. Submitted by Alan Frier, Cadillac, Michigan.
3. "Construction Zone—Ski Carefully"—at bridge over Cerritos Channel, near Long Beach, California. Submitted by Willard M. King, Los Angeles.
4. "This is Not U.S. 40"—near Junction U.S. 13 & U.S. 40 in Delaware. Submitted by William J. Miller, Jr., Deputy Chief Engr., State H'way Dept., Dover.
5. "Norway 14, Naples 23, Mexico 37, China 46, etc."—Junction 5 & 35, Lynchville, Maine. Submitted by Richard A. Luettich, Asst. Traffic Engineer, State Highway Commission, Augusta, Maine.
6. "Slow (Snail)"—Sudivision east of Illinois 59 and north of Barrington, Illinois. Submitted by Warren H. Brandt, Field Engineer, Bureau of Traffic, Illinois Division of Highways, Elgin.
7. "We're Not Fooling—30 MPH"—Western Nebraska, 2 locations. Submitted by Robert L. Meyer, Traffic Engineer, Dept. of Roads, Lincoln, Neb.
8. "Slow—Pheasant Crossing"—on Santa Fe Grade, Fresno County, California. Submitted by Peter G. Koltnow, Traffic Engineer, Dept. of Public Works, Fresno, California.
9. "Caution—Drive with Care—Horse Players Path"—33rd and Cicero Avenue, Chicago. Submitted by Several persons.
10. "Somewhere Ahead—Radar"—U.S. 301 near Fayetteville, N. C. Submitted by James E. Angell, Traffic Engineer, Santa Monica, Calif. (Photo by No. Carolina Highway Patrol)
11. "Stop—Stop—Stop" (cluster)—Albuquerque, New Mexico. Submitted by Francis C. Burton, Albuquerque, New Mexico.
12. "Drive Carefully—Hell Ain't Half Full"—near Kelly Air Force Base, Texas. Submitted by Fred Potenza, Traffic Dept., National Safety Council, Chicago (Photo courtesy Off. of Information, Kelly AFB)

(Photos shown above are available from Beveridge Organization, Inc., 201 N. Wells St., Chicago 6, Ill.)

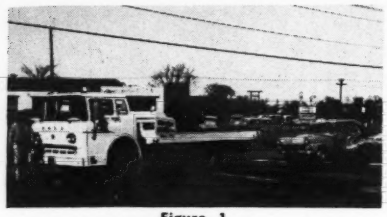


Figure 1
Piggyback Wrecker arrives at scene of accident.

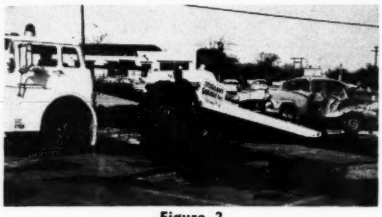


Figure 2
Wrecked vehicle is pulled onto tilted platform by hydraulic winch.

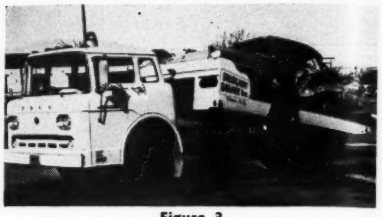


Figure 3
Platform is returned to normal position and Piggyback Wrecker is ready to go within one minute of arrival at scene of accident.

Piggyback Wrecker Requires No Towing

The conventional method of towing wrecked or disabled automobiles may soon be a thing of the past because of the invention of a service station owner in Utica, New York. The new device would help clear freeways quickly and avoid the problems of towed vehicles on expressways.

Convinced that the only way to overcome the many problems that go with towing a vehicle was to develop an entirely new method, "Oriskany Joe" Klosek, of Utica, designed and built in his service garage a piggyback wrecker he claims is faster, safer and more economical than the conventional wrecker.

The piggyback wrecker is a cab-over chassis with a 16-foot flatbed platform mounted on top of the chassis. The platform is mounted on metal rollers and ball bearings so that it can slide eight feet to the rear and then be tilted at a 12-degree angle until the rear end of the platform touches the ground. A powerful hydraulic winch located at the front end of the platform pulls the automobile onto the tilted platform which is then returned to its normal horizontal position. Movement of the platform and operation of the cable winch are handled by three hydraulic control levers located on the driver's side of the chassis.

Demonstrations showing how the piggyback wrecker can load a disabled automobile onto the chassis and be on the way to a service garage *within one minute* have greatly impressed highway officials responsible for the movement of traffic on freeways, bridges and in tunnels. The ability of the new wrecker to move, with a disabled automobile, at normal traffic speeds is of interest to both highway officials and service garage operators. And the owner of the automobile likes not having to worry about possible towing damage to the bumper, the air suspension or the transmission.

Off-highway wrecks are no problem to this versatile vehicle since a four-way removable pulley at the rear of the platform enables the hydraulic winch to pull the automobile onto the highway from streams, steep embankments, fields, etc. Another feature is that while carrying one automobile on its chassis the piggyback wrecker can tow a second automobile by the use of a special tow bar attached to the rear of the chassis.

After completing his new wrecker, "Oriskany Joe" wasted no time in filing a patent and in accepting an invitation by the patent office to demonstrate it in Washington. He then put the wrecker into daily use at his Utica service garage for a period of eighteen months, during which it was tested under all types of conditions and unusual situations.

Finally convinced that the piggyback wrecker was far superior to conventional wreckers and should be standard equipment for other service garages, he recently granted to Transportation Equipment Development Corporation, Washington, D.C., an exclusive license to manufacture vehicles embodying his invention.

Sales agency for the piggyback wrecker, Washington Industrial Research Consultants, Inc., 1625 Eye Street, N.W., Washington, D.C., claims the selling price is comparable to that of conventional wreckers. The agency also reports that the first order for a production model of the new wrecker came from the operator of a service garage in Utica, New York—"Oriskany Joe" Klosek.

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engineering and design features that have made Time-O-Matic the leading manufacturer of flashers since 1932

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- not affected by extreme temperature variations
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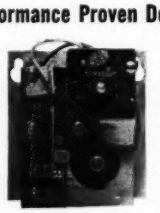
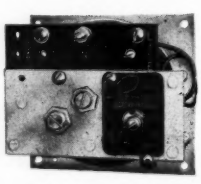
- hardened, polished pivots
- bearings, factory lubricated for life of the flasher
- available with or without radio interference eliminators



NEW ! !
Model 46
1 or 2 circuit, front-mounted cams and contacts out in the open for fast, easy adjustment, replacement. Compact size 4⅜" high, 4" wide, 2¼" deep



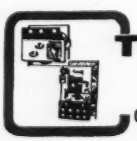
Model 3
1 or 2 circuits

Model 37 Jack-mounted
Available with or without meter base and cover, as shown, 1 or 2 circuits

Applications

Safety Zones
Caution Signals
Traffic Islands
Loading Zones
Warning Beacons
Flashing Stop Signs

Write for literature and specifications



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Pedestrian Overpass Used in Lansing

A solution to the problem of getting pedestrian traffic safely across a high-volume, high-speed street has been solved in Lansing by a carefully-engineered pedestrian overpass, known as Sky-Walk, designed with many safety features that have brought praise from municipal, school and police representatives. Sky-Walk is manufactured by C. D. Scarlett Company, Inc., of Lansing, Michigan.

It crosses a main road that is quite heavily traveled, especially morning and evening. The speed limit in this area is 45 miles an hour, and speeds are frequently in excess of this figure. particularly with incoming traffic.

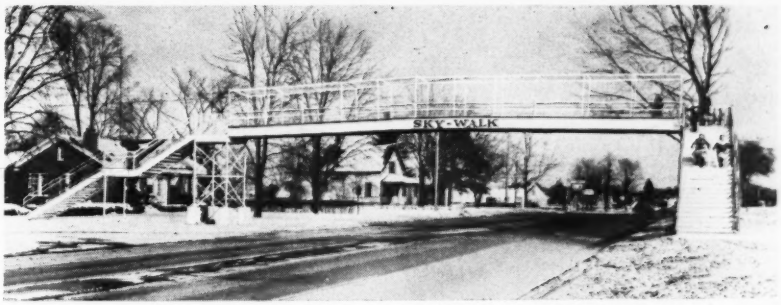
Allen T. Hayes, traffic engineer for the city of Lansing points out, "Twenty-four hour, year 'round availability for pedestrian crossing, with none of the problems usually associated with these facilities, is the main advantage of this type of pedestrian overpass. This installation practically eliminated complaints about children crossing this street with a 45 mph speed limit, even with the protection of a school crossing watchman. The crossing man is no longer needed.

"We like this pedestrian overpass because it eliminates the vehicle-pedestrian conflict, it permits the retention of a reasonable speed limit in this area, and it has postponed the installation of a traffic signal, which under present traffic conditions, is not warranted."

Sky-Walk was designed by a leading bridge engineer, and is in effect a "package" of standard components that can be adapted to a variety of situations to carry pedestrians up and over traffic while providing maximum safety both to pedestrians and motorists. It has been approved by Michigan insurance companies, and the structure erected in Lansing was approved by the Michigan State Highway Department.

Support for the Sky-Walk is provided by a four-column tower at either end. The tower also serves as a platform or landing that joins the overpass spans with the stairways leading to and from the overhead walkway.

Spans are set into saddles on the towers, bolted into position and bolted together. As presently engineered, the design will permit a total span of 82 feet, making the structure adaptable.



The stairways also are bolted to the towers and the towers themselves are bolted onto poured-in-place, reinforced concrete foundations. This, everything but the foundations are movable so that the Sky-Walk can be expanded or moved, if so desired, and so that the overhead spans can be removed if an object is transported along the highway that would exceed the normal 15-foot clearance of the Sky-Walk. This clearance can be made greater or smaller for specific sites.

Flooring and stair treads are made of 12-gauge open-grid steel grating, making them self-cleaning for surer footing in climates where snow and ice could be problems with solid flooring. This also makes the structure cleaner by not permitting dirt and debris to collect.

Railings and frame are 1⅝" steel tubing, structural members are steel tubing and the entire walkway is enclosed, sides and tops, with cyclone fencing to thwart youngsters tempted to do acrobatics and to prevent large objects from being thrown onto cars.

Kerrigan Announces Expansion Program

Kerrigan Iron Works Co., Nashville, Tennessee—a subsidiary of Rockwell-Standard Corporation—announced a program of plant expansion, including new automatic equipment, to improve quality and speed service. Recognizing the steady growth of the lighting standard market, and to better serve municipal engineers, utility engineers, electrical contractors and wholesalers, Kerrigan has recently added the following sales representatives: Berry-Rochi, Inc., Long Island City, New York to cover the New York City and Long Island trading areas; R. W. Mitscher Company, Inc., Buffalo, for New York State; Connecticut and southwest Massachusetts has been asisgned to Baynes, Inc. of Hartford; New Jersey to P. M. Dreyfuss & Son of New Shrewsbury, New Jersey; Michigan to J. J. Gorman Company in Detroit; Virginia to Charles C. Laney Agency of Richmond; and C. D. White Company of Boston to the New England States.

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TRAFFIC GUIDES
Use SAFE-T-CONES wherever traffic is difficult. Proven and accepted by Federal, State and Municipal traffic authorities in hundreds of major cities.
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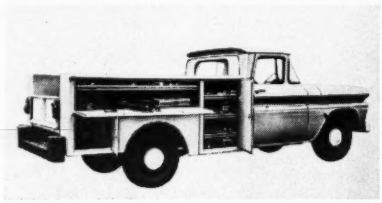
For full information write
RADIATOR SPECIALTY CO., CHARLOTTE, N. C.

Reading Offers New Utility Bodies

Reading Body Works, Inc., Reading, Pa., has added a new series of job-planned utility bodies for the 1960 Chevrolet and GMC three-quarter ton chassis.

The new bodies, called the 964 Series, are six-inches longer than last year's models. Front storage compartments have been increased in length and lowered to complement the streamlined design of the new Chevy's and GMC's. The new bodies measure 96-inches in over-all length to conform with increased cab-to-axle dimensions of these makes, a company spokesman said.

The newly-designed body provides a lower center of gravity which increases roadability and maneuverability for



the entire vehicle. The lowered body dimension affords unobstructed vision from the rear window of the cab.

Also highlighted in the 1960 Reading line are adjustable and removable dividers and removable shelves in the weather-tight storage compartments. The bodies are electrically-welded into one integral unit. Completely undercoated understructures are provided at no extra cost.

New body models for the 1960 lines of Ford and Dodge trucks have also been introduced by Reading.

New Appointments

Lewis Joins Consulting Firm As Partner

Mr. Brian J. Lewis (Jun. Mem. ITE) has recently joined Whipple, Murphy, Pearson & Associates, Palo Alto, as a partner. In his new position he will specialize in the fields of traffic, high-

ways, planning and feasibility studies. He will also be in charge of an office in Seattle.

Mr. Lewis was formerly Traffic and Transportation Engineer in charge of the Seattle office of Porter, Urquhart, McCreary & O'Brien. A native of England, he is a civil engineering graduate of the University of Durham there. He also attended and was on the staff of the Institute of Transportation and Traffic Engineering at Berkeley and Los Angeles, receiving his M.S. degree in 1954.

He is a registered professional engineer in four states, and is also a member of ASCE and the HRB. He was recently appointed a member of the Governor's State of Washington Expenditures Advisory Council, the subcommittee investigating highways and non-highway transportation.

Job Changes

Jack Berman—formerly Highway Research Engineer with the U.S. Bureau of Public Roads in Washington, D.C.; is now Assistant Highway Planning Engineer with the Port of New York Authority in New York City.

Rafatel Cal y Mayor — formerly Sub-Director de Telecomunicaciones of the Comite Nacional de Comunicaciones Vecinales in Mexico; is now Director General of Centro de Adiestramiento de Operadores in Mexico.

William N. Ferro—formerly District Traffic Engineer with the Virginia Department of Highways in Salem, Virginia; is now Chief Traffic Engineer with the Metropolitan Planning Commission of Knoxville, Tennessee.

Edward F. Granzow—formerly Traffic Analyst with the Pasadena Police Department; is now Traffic Engineer for the City of Anaheim, California.

Hans W. Nintzel—formerly Assistant Civil Engineer with the New York Department of Traffic; is now Programmer—Digital Computers with Computer Usage Co. in New York City.

James B. Robertson—formerly Associate Traffic Engineer for the City of Richmond, California; is now Traffic Engineer for the City of San Leandro, California.

David K. Witheford—formerly Planning Engineer with the Delaware State Highway Department in Dover, Delaware; is now Assistant Study Director of the Pittsburgh Area Transportation Study in Pittsburgh, Pennsylvania.

Title Changes

Edmund J. Cantilli — is now Traffic Engineer II for The Port of New York Authority; was Highway Project Planner.

William R. Marston — is now City Traffic Engineer for the City of Chicago; was Deputy City Traffic Engineer.

Coming Events

May 30-June 10 — O.T.C. TRAFFIC TRAINING COURSES—
Sixth Annual Course sponsored by Ontario Traffic Conference in cooperation with Huron College and the University of Western Ontario, London, Ontario. Contact: R. F. Anderson, Sec.-Treas., O.T.C., 2001 Eglinton Ave. East, Toronto, Ont.

June 8-11—NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS—
Annual Meeting, Statler Hotel, Boston, Mass. Contact: Kenneth E. Trombley, NSPE, 2029 K Street, NW, Washington 6, D.C.

July 17-20—WESTERN SECTION, ITE—
Annual Meeting, Jack Tar Hotel, San Francisco, Cal. Contact: Ross T. Shoaf, City Traffic Engineer, San Francisco, Cal.

September 12-16 — INSTITUTE OF TRAFFIC ENGINEERS—
30th Annual Meeting, Edgewater Beach Hotel, Chicago, Ill. Contact: ITE, 2029 K St. N.W., Washington 6, D. C.

September 19-22—INTERNATIONAL MUNICIPAL SIGNAL ASSOCIATION—
Annual Meeting, Astor Hotel, New York City. Contact: Irvin Shulsinger, IMSA, 130 West 42nd Street, New York 36, N.Y.

September 26-30—FIFTH INTERNATIONAL TRAFFIC STUDY WEEK—
Nice, France. Contact: M. H. Perlowski, Secretary to the OTA/PIARC/IRF Joint Committee, 32 Chesham Place, London S.W.1, England.

October 9-12—AMERICAN TRANSIT ASSOCIATION—
Annual Meeting, Sheraton Hotel, Philadelphia, Penna. Contact: ATA, 355 Lexington Ave., New York, N. Y.

October 9-13—AMERICAN SOCIETY OF CIVIL ENGINEERS—
Annual Convention, Statler Hotel, Boston, Mass. Contact: ASCE, 29 West 39th St., New York, N. Y.

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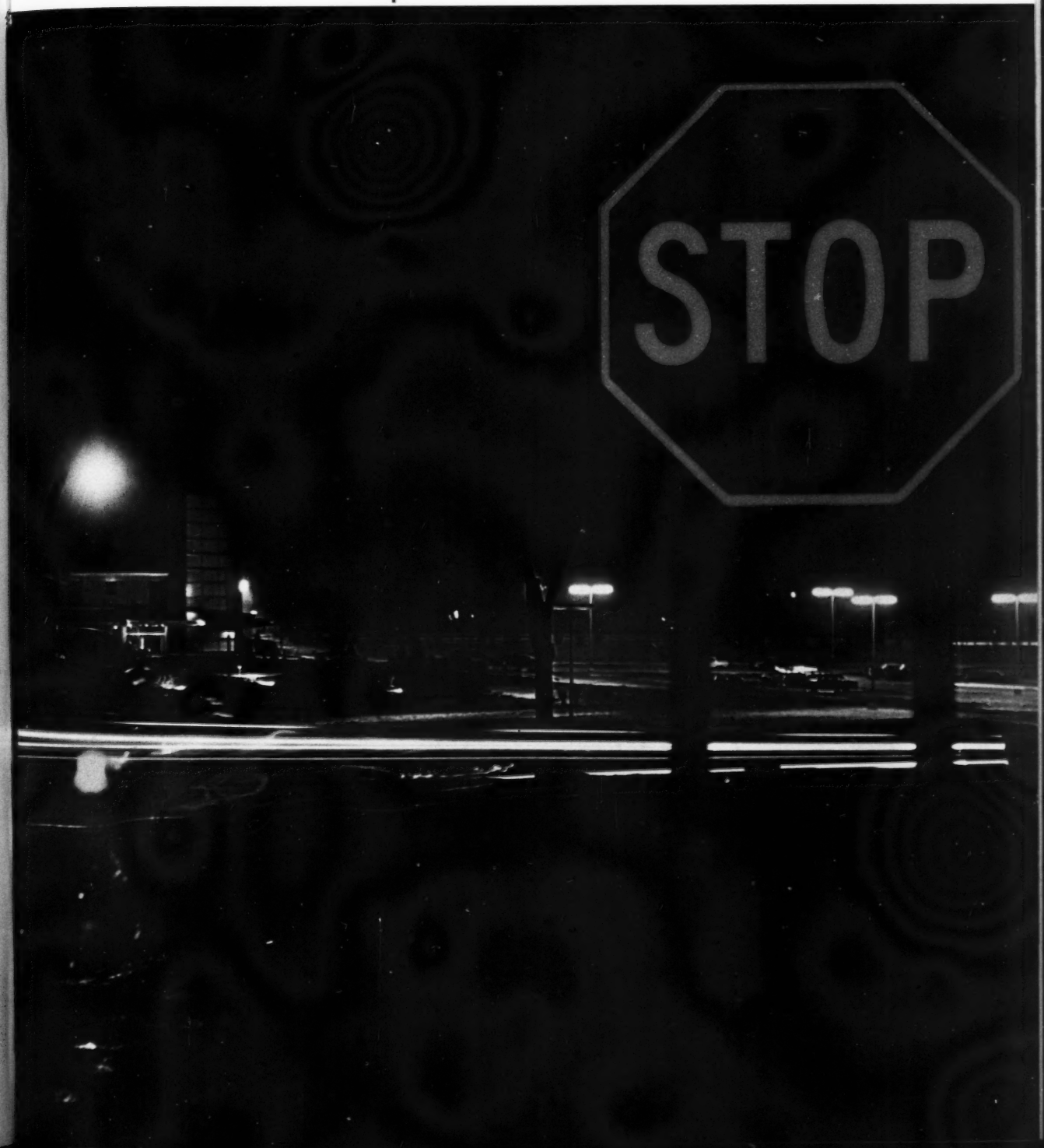
FULL TIME TRAFFIC CONTROL

that works effectively in any weather

This miniature sample sign face is made with "Scotchlite" Reflective Sheeting



HOW TO PROVE BRILLIANCE OF SCOTCHLITE®
BRAND
REFLECTIVE SHEETING

The miniature Stop sign attached to the reverse side of this page is made of "Scotchlite" Sheeting. To see it work brilliantly, just as modern reflective traffic signs do, set up page in a dark room as shown. Stand back at least 15 feet. Hold flashlight close to your eye level to simulate headlights ("Scotchlite" Sheeting reflects light beams only to their source).

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Traffic signs of "Scotchlite" Reflective Sheeting guide, warn, and control motorists day and night with powerful full time, full color visibility.

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Signs of "Scotchlite" Sheeting appear the same in shape, color, and legend 24 hours a day. Uniform signs are quickly recognized and obeyed.

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Reflective signs that "black-out" in nighttime downpours fail when needed most. Signs of "Scotchlite" Sheeting reflect in any weather.

Full Reflectivity at All Angles

Even at extreme angles to light source, "Scotchlite" Sheeting reflects with full impact. Signs bent by accident remain in full sight at night.

No other reflective sign material or device gives you all these vital features. None give you the exceptional full time effectiveness, the long life durability and outstanding long run economy of "Scotchlite" Reflective Sheeting! Learn more about modern reflective traffic control—call or write your 3M Representative today!

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New Publications

The Long Range Effect of Enforcement on Driving Speeds

By Robert P. Shumate, Service Division, International Association of Chiefs of Police, Barr Bldg., Washington 6, D.C. 22 pp. & appendix. Free.

This report studies differences in drivers' speeds before and after concentrated enforcement. In general, the study concludes that the application of enforcement does not cause drivers to reduce speed.

The Effect of Pneumatic Road Tubes On Vehicle Speeds

By Richard F. Crowther. Robert P. Shumate, & R. Dean Smith. The Traffic Institute, Northwestern University, Evanston, Ill., 76 pp. & appendix. Free.

This report studies the effect of pneumatic tubes on speeds of vehicles passing over them. Such tubes are commonly used, of course, in making speed studies. The study concludes that such tubes do produce errors, with measured speeds being below real speeds. The error does not appear to be systematic, however, and no correction constant is suggested.

Automobile Facts and Figures 1959-60 Edition

Automobile Manufacturers Association, New Center Bldg., Detroit 2, Michigan. 72 pp. Free.

An annual summary of data on vehicle manufacutring, sales and use, which provides valuable background for traffic people.

You and the Cost of Highway Accidents

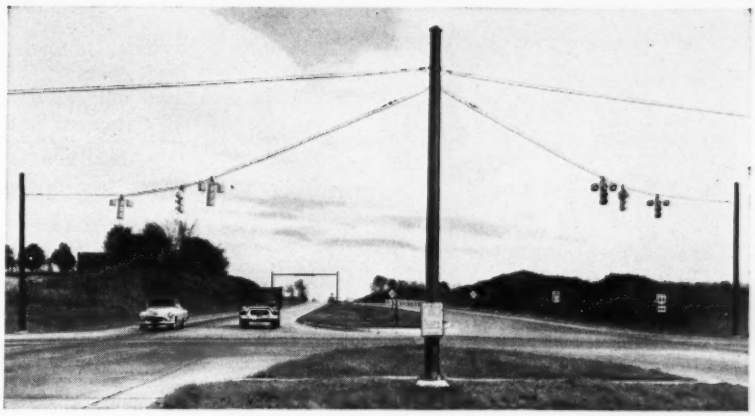
State Road Commission of Utah, Salt Lake City, Utah. 1960. 31 pp. Free.

A booklet, designed for popular consumption, which reports some of the facts about accident costs developed from a study conducted jointly with the Bureau of Public Roads. The data will be very useful in the economic justification of highway improvements.

Parking Dimensions—1960 Model Cars

Automobile Manufacturers Association, 320 New Center Bldg., Detroit 2, Michigan. 1960. Folded sheet. Free.

An annual publication which provides a tabulation of outside dimensions and clearances on all 1960 U.S. cars, useful for garage designers, lot designers, and traffic engineers.



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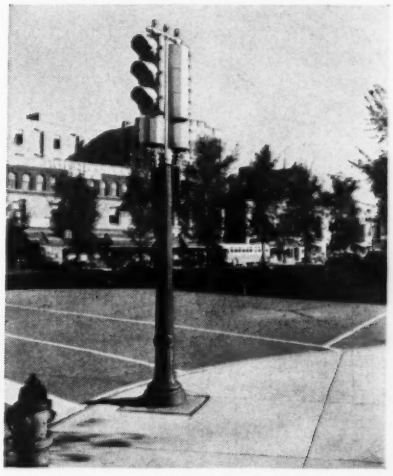

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Technical Notes

A MODEL PERFORMANCE SPECIFICATION FOR PURCHASE OF PAVEMENT MARKING PAINT

Institute of Traffic Engineers, Technical Report No. 4

This model specification was developed by Technical Committee 7-D of the Institute of Traffic Engineers, and was approved by the Technical Council on January 9, 1960. It was adopted as an Institute Standard by the Board of Direction on January 16, 1960.

Part A — General

1. INTENT OF SPECIFICATION. It is the intent of this specification to describe the general and specific requirements for reflective paints to be used by the (*State or City*)* in its pavement marking program, as well as to provide for the submission of samples and to describe the laboratory and service test procedure which will be used to rate the paints submitted for test. It is intended that samples will be received under this specification from any individual, company or corporation desirous of furnishing traffic paints to the (*State or City*), that such samples will be subjected to appropriate laboratory and field service tests, and that the (*State or City*) will request competitive bids for the (*State's or City's*) requirements on such paints as prove satisfactory. It is expected that the field service test will require six months or more for completion. A statement of the characteristics of each type of paint must be furnished by the paint supplier on the attached forms.

NOTE: This model specification is a *performance* specification. It should be recognized that paint can also be purchased on the basis of *chemical* or *composition* specification.

2. TYPE OF PAINTS. This specification covers a ready-mixed paint product of spraying consistency which shall be suitable for use as a reflecting traffic guide on Portland cement concrete or bituminous pavement. The paint may be of any of the following types:

(a) A type in which the glass spheres are mixed in the paint during the process of manufacture (hereinafter designated as the premix type) so that upon drying (and subsequent to exposure of the spheres due to wear of the paint film) the paint line is capable of retrodirection of the headlight beams from vehicles, or

(b) A type in which glass spheres are dropped by suitable means into the wet paint as it is applied by the pavement marker (hereinafter designated as the drop-in type), or

(c) A type which combines the characteristics of premix and drop-in paints, i.e., having beads mixed in the paint and also requiring some beads to be dropped on the paint at the time of application (hereinafter designated as the combination type).

3. METHODS OF TESTING. The methods of sampling and testing all materials and products covered by this specification shall be in accordance with the latest standards of the American Society for Testing Materials, the American Association of State Highway Officials, the Federal government, or of other recognized standardizing agencies as indicated for each material.

Part B — Properties of Paints

1. CONDITION AND STABILITY. The paint shall be homogeneous, shall be well ground to a uniform and smooth consistency, and shall not skin nor settle badly, nor cake, liver, thicken, curdle, or gel in the container. The paint shall be capable of being broken up and mixed without difficulty by use of a paddle and shall show the desired characteristics at any time within a period of six months from date of delivery. The paint shall be tested in accordance with ASTM Designation D-869 and a paint rated below (*4*) shall be considered unsatisfactory.

2. FOREIGN MATTER. The paint shall be free from skins, dirt, and other

* The name of the state or city, or the name of the commission, department or other purchasing authority should be inserted at all points shown as: (*State or City*). Elsewhere throughout this model specification, values in parentheses and italicized, as (*40*), are suggested values, and other values appropriate to the specific needs or requirements of the particular purchasing authority may be substituted.

foreign matter and shall not contain more than 1% water. (The paint shall be tested in accordance with Methods 4081, 4091 and 4092 of Federal Test Method No. 141.)

3. SUITABILITY TO APPLICATION. The paint shall be suited to application by means of spray-type pavement marking equipment used by the (*State or City*), and when used with such equipment shall be capable of producing a solid, full-width line of the required thickness.

4. DRYING TIME. The paint, when applied with its complement of beads to a concrete or bituminous pavement surface under normal field conditions at the required rate and at air temperatures between (*60° and 80°*) F. and relative humidities less than (*60*) per cent, shall dry sufficiently hard within (*45*) minutes after application so that there will be no pickup, displacement, or discoloration under traffic. The paint may also be tested in accordance with ASTM Designation D-711 and when so tested it shall dry to no pickup in not more than (*30*) minutes.

NOTE: It would be reasonable to specify a drying time anywhere between twenty-nine and sixty-one minutes. A drying time of forty-five minutes is recommended.

5. VISCOSITY. The paint, as received, shall have a consistency as determined on the Stormer Viscosimeter and expressed as Krebs units at 77° F. of (*70-90*) for any type of paint. (ASTM Designation D-562). The paint will be applied without thinning with the temperature of the paint above (*65°*) F. Any paint which changes consistency within six months after receipt so that the consistency falls outside the viscosity limits stated above, shall be considered to have failed this requirement.

NOTE: A viscosity range of 70 to 80 Krebs units at 77° F. is recommended for drop-in type paint and a range of 80 to 90 Krebs units at 77° F. is recommended for pre-mix or combination types of paint.

6. COLOR. This paint shall conform to U. S. Bureau of Public Roads Standard yellow (green to red tolerance), or standard white, as required by the order. The color determination shall be made after the paint has dried for 24 hours on premix as received and on combination and drop-in type after the beads have been dropped in. The paint shall not contain any organic coloring matter and shall not discolor in sunlight.

NOTE: If a light yellow shade of yellow is desired, a green to standard tolerance should be shown. If an orange-yellow shade is desired, a standard to red tolerance should be shown.

7. BLEEDING. When tested and evaluated on both tar and asphalt substrates in accordance with the Method of Laboratory Test for Degree of Resistance of Traffic Paint to Bleeding, ASTM Designation D-969, and the Method of Evaluating Degree of Resistance of Traffic Paint to Bleeding, ASTM Designation D-868, the numerical rating of degree of bleeding for both white and yellow paints shall be not less than (*6*). Paints will be tested for bleeding

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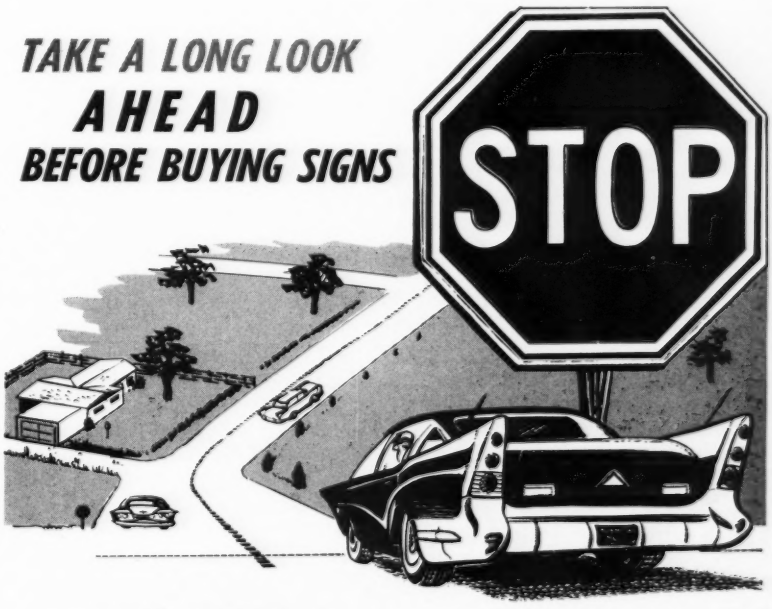

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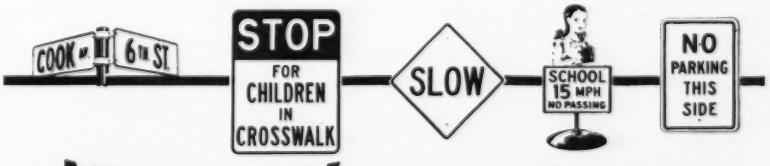

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with the prescribed quantity of beads in or on the paint.

8. WET HIDING POWER. The pigmented binder when applied at the rate of 10 mils wet film thickness over a Morest Black and White Hiding Power Chart, Form 03-B, shall show complete hiding or give a contrast ratio of not less than (*0.98*) between the reflectance of the black and of the white chart surfaces as determined by a Hunter Multi-Purpose Reflectometer.

9. PAINTS LACKING DESIRED PROPERTIES. Any paint sample which fails to have the required properties listed in paragraphs 1 through 8 above shall be considered as unsuitable for further test, and the (*State or City*) shall not be obligated to include it in the road service test, nor to consider it for purchase.

Part C — Road Service Test

1. INTENT OF SPECIFICATION. It is the intent of this portion of the specification to describe a procedure to be followed by manufacturers and others in submitting samples for this test, and the procedure which will be followed by the (*State or City*) in testing the paints submitted, to determine the most economical paint for the (*State or City*) to purchase. Only paints submitted for performance test under the specification and thereby found to be acceptable will be considered when bids are taken. It is therefore the responsibility of the manufacturer to submit for test samples of all types and colors of paints on which he later may wish to submit bids.

2. SAMPLES REQUIRED. (a) An invitation to submit samples may be issued several months in advance of the invitation to submit bids in order to permit evaluation of the service test results. All samples shall be properly identified with the manufacturer's code number, which shall be different for each type and color submitted. The manufacturer's name, address, type of paint and code number for each sample shall be submitted separately.

(b) Each sample shall consist of the following amounts of each paint which the manufacturer proposed to furnish:

(1) For Premix Type Paints:
- (a) Two (2) one-gallon cans of the finished product.
- (b) Three (3) one-quart cans of the finished product.
- (c) Two (2) one-quart cans of the paint without beads.
- (d) Ten (10) pounds of beads.
- [(e) OPTIONAL: One (1) five-gallon can of the finished product.]

(2) For Drop-In Type Paints:
- (a) Two (2) one-gallon cans of the finished product.
- (b) Three (3) one-quart cans of the finished product.
- (c) Twenty-five (25) pounds of beads.
- [(d) OPTIONAL: One (1) five-gallon can of the finished product and 30 pounds of beads.]

(3) For Combination Type Paints:
- (a) Two (2) one-gallon cans of the finished product.
- (b) Three (3) one-quart cans of the finished product.
- (c) Two (2) one-quart cans of the paint without beads.
- (d) Ten (10) pounds of pre-mix type beads.
- (e) Twenty-five (25) pounds of drop-in type beads.
- [(f) OPTIONAL: One (1) five-gallon can of the finished product and sufficient drop-in beads.]

NOTE 1.: The one-gallon samples are for the road service test, the one-quart samples are for the laboratory tests, including can stability; the five-gallon samples are for the State's or City's use to determine if the paints will perform satisfactorily in its regular marking equipment and they will therefore be applied under normal operating conditions and at prescribed application rates.

NOTE 2.: The number of samples that will be accepted from each manufacturer can be reduced if the State or City does not desire to accept the number of samples permitted in the model specification.

(c) On each invitation to submit samples, each manufacturer may submit not more than (*three*) samples of each color paint. If more than (*two*) samples of a single color are submitted, at least two types (drop-in, premix and combination) of paint shall be represented. Samples of each color as well as each type of paint which the manufacturer desires to have tested shall be submitted as each color will be rated separately even though of the same brand.

3. CERTIFICATIONS REQUIRED. (a) Certificate of Compliance. The manufacturer shall submit for each sample a Certificate of Compliance on the form provided certifying that the sample meets all of the requirements in this specification.

b) Statement of Characteristics. The manufacturer shall submit with each sample a Statement of Characteristics on the form provided, giving weight per gallon at 77° F., drying time, viscosity, per cent pigment, per cent nonvolatile in vehicle, chemical nature of the non-volatile, pigment volume concentration, the pounds of chrome yellow or titanium dioxide (or substi-

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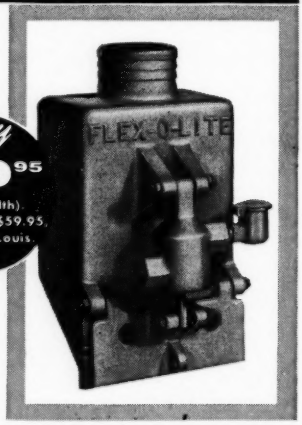

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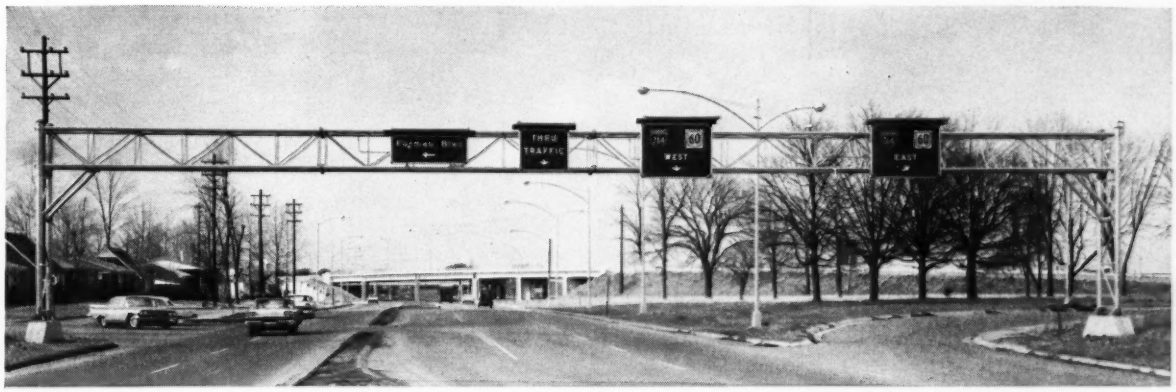

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Planet all-aluminum overhead sign structures are rugged . . . the box-truss design enables Planet sign structures—*even structures 120-feet long*—to support large overhead signs and lights in winds in excess of 100 m.p.h.

And Planet sign structures are handsome . . . the aluminum's smooth, clean appearance, and natural defiance to the elements assures you that these inexpensive-to-erect overhead sign structures will *stay attractive for years without maintenance.*

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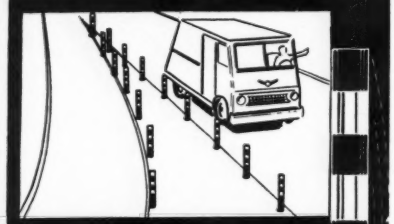

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Exclusive snap-in and snap-out feature puts them to work full time or part time as you wish. 3 types in 3 sizes: 14", 20" and 26" heights with reflective yellow bands. For details and prices write:

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NO. 100 MODEL
STANDARD SURFACE TYPE

No holes to drill, no bolts to install. Mix equal parts of mastic and catalyst together (two parts of catalyst to one part of mastic when temperature is 32° or less.) Apply mastic to bottom side of casting flange and set FLEX-O-GUIDE in position. It takes a minute; anybody can do it.

NO. 200 MODEL
SURFACE TYPE SNAP-IN

Same installation as No. 100 Model. The FLEX-O-GUIDE has place for a spanner wrench to be used for removal and installing FLEX-O-GUIDE.

A dust proof cover can be provided for 200 and 300 models, if required.

NO. 300 MODEL
BELOW SURFACE SNAP-IN

A five (5) inch diameter hole must be made in surface to the depth of three (3) inches. The female casting is then set in the hole with any fast setting cement grout. The FLEX-O-GUIDE has place for a spanner wrench to be used for removal and installing FLEX-O-GUIDE.

tute) per gallon of yellow or white paint, respectively, pounds of glass spheres per gallon in premix type of paint, pounds of glass spheres to be applied with each gallon of drop-in or combination type paint, gradation of spheres and per cent of spheres not round, type of solvent to be used for thinning, and recommended rate of application of the paint. This statement shall be for the confidential use of the department, and the information therein will not be revealed by the department, but will serve and assist in identifying and testing paint furnished.

4. Submission of Samples and Certifications: Samples, Certificates of Compliance, and Statements of Characteristics shall be sent prepaid to the (*State or City*). Unless the samples and corresponding Certificate and Statements of Characteristics are received by the hour and date fixed in the inquiry for the receiving of such samples, the (*State or City*) shall not be obligated to include the samples in the test nor consider them for purchase.

Note: Due to the time required for the preparation of samples by manufacturers, the inquiry should allow 45 to 60 days for the submission of samples.

5. Service Test: (a) Application. The test stripes shall be four inches in width and applied both longitudinally and transversely. Application in longitudinal stripes will be by regular painting crews using routine department methods and standard pavement striping equipment. Application in transverse stripes will be by selected personnel under the supervision of the (*State or City*) using a special pavement marking machine with a spray nozzle similar to the spray nozzles used on the regular pavement marking equipment.

For tests of transverse stripes, the paint shall be applied to four sections of highway, two of which have a concrete surface, and the other two a bituminous surface. The sections selected shall be areas where traffic is heavy and wear is uniform with full exposure to the sun throughout the daylight hours. The test areas shall be laid out where traffic is free-rolling, and with no grades, curves, intersections, or access points near enough to cause excessive braking or turning movements.

In the transverse test sections, at least three lines of each sample shall be applied in such order that differences due to position and time of day when placed will be compensated for, insofar as it is practical to do so. The paint shall be applied at the rate recommended by the manufacturer within plus or minus 10 per cent as determined by quantitative measurements made of the area of line applied per unit volume of material. If no rate is specified by the manufacturer, the paint will be applied at the rate of 16.5 gallons per mile of four inch continuous stripe (wet film thickness of 15 mils), and beads at the rate of 6 lb. per gallon of paint on drop-in type and 3 lb. per gallon on combination type.

Note: The number of test lines can be reduced if the State or City does not intend to apply the paint to both Portland cement concrete pavement and bituminous pavement. Test lines are needed only on the type of pavement that is to be marked.

(b) Evaluation. The ease and uniformity of application, covering properties, and drying time will be determined at the time paints are applied on the road, and the comparative results obtained on these properties of the various paints will be taken into consideration in the final evaluation.

[Optional: Unless otherwise specified, the longitudinal stripes will be used to evaluate handling and application characteristics, and the transverse stripes to evaluate performance in service of the paints included in the test.]

All samples received for test will immediately be given a code identification number which shall be recorded and filed with the manufacturer's code number and certifications. All identification other than the said code identification number shall be removed from the sample containers and the code number shall be used for identification of the material for all succeeding operations of testing, application, and field rating of the material.

Periodic inspections will be made of the test sections in accordance with ASTM Designation D-713, D-821, D-913, and D-1011. Records will be made at each inspection of general

daytime appearance (including color), film condition, and luminous directional reflectance.

NOTE: It is desirable to carry on the inspections for a period of one year, or until all of the transverse test lines are more than fifty per cent worn off in the wheel tracks. Representatives on the inspection team may be varied as desired. It is recommended that the traffic, maintenance, materials and purchasing bureaus or departments be represented on the inspection team. The intervals between inspections need not follow ASTM test procedure if it is not specified.

Evaluation of service will be based on appearance, durability, and night visibility as defined in paragraph (c) of this section. The test lines will be rated numerically from very poor to perfect, using numbers of 0 to 10, with number 10 indicating perfect condition, and 0 complete failure.

(c) Definitions:

Appearance. This is the complete impression conveyed when the painted surface is viewed at a distance of at least 10 feet before any detailed inspection has been made, and is estimated purely in terms of satisfactory or unsatisfactory appeal to the observer. It also includes a comparison of the color of the surface under consideration with the original color, taking into account changes due to yellowing, darkening, fading, dirt collection, mold growth, etc. The determination is to be made without preliminary washing or other modification of the surface of the test lines.

Durability. The factor used in rating film failure is equal to one-tenth of the percentage of material remaining on the pavement when examined closely by the unaided eye, this determination to be made in each wheel track in an area extending nine inches each side of the point of greatest wear. Percentage of paint remaining on the pavement will be considered as the percentage of the prescribed area of test stripe in which the substrate is not exposed.

Night Visibility. Night visibility designates the apparent brightness when examined at night under tungsten illumination from the side of the road, with eye and light source separated by a distance which corresponds to a divergence or viewing angle of approximately 1/3 degree. Photometric readings, made in accordance with ASTM Designation D-1011, may be substituted for the visual comparison at the option of the (*State or City*), the rating being based on a factor of 10 for the highest reading and 0 for complete failure. Night visibility determinations will be made on the same areas as those used for rating durability.

Service Factor (R). In evaluating each sample at the end of the test (or at any time prior thereto) a Service Factor (R) will be determined for each quality (R_A for appearnce, R_D for durability, R_N for night visibility) on the basis of the following formula (in which each value of r is the average of the ratings for the specific quality by all (*four*) observers for all four test sections) at the time (t) in days between successive evaluations. The time t_x at which the rating of a paint goes below (*4*) (which is r_x) at the time of any inspection will be determined by interpolation.

$$R = \frac{r_1t_1 + r_2t_2 + r_3t_3 \ldots\ldots r_xt_x}{t_1 + t_2 + t_3 \ldots . t_x}$$

NOTE: When it is desired to determine the service factor, etc., separately for concrete and bituminous surfaces, a separate set of calculations will have to be made for the ratings on the two materials.

Weighted Rating (W). The three qualities of appearance, durability and night visibility are not considered of equal importance in rating a paint and will be weighted as follows:

Appearance—(*10*)%
Durability—(*40*)%
Night Visibility—(*50*)%

The weighted rating (W) of a paint will therefore be determined by the formula:

$$W = \begin{matrix} (0.10)\ R_A + (0.40)\ R_D \\ + (0.50)\ R_N \end{matrix}$$

in which R_A, R_D and R_N are the service factors for appearance, durability and night visibility.

NOTE: The weights given to appearance, durability and night visibility may be varied to suit local conditions. If the paint line is to be applied to a well-illuminated city street, the weight for night visibility could be reduced and the weight of either appearance or durability increased. The weights shown are recommended for rural highways carrying a heavy volume of nighttime traffic. The weights of appearance, durability and nighttime visibility can be varied, but the three weights must total one hundred per cent.

(d) Final Evaluation. (*One year*) after application of the test stripes, or whenever all paints are rated below (*4*) in one or more of the service factors, a final evaluation will be made and the weighted rating for each paint will be determined. The average of the figures of performance for all four test sections arrived at by all (*four*) observers of the committee will be used to determine the final figure of performance or weighted rating for each paint sample.

NOTE: The one year shown can be decreased if the results must be obtained at an earlier date, but it is desirable to subject the transverse test lines to both summer and winter wear and deterioration. Whenever the final evaluation is made, if any rating has previously fallen to (*4*), the corresponding final time increment t_x shall not extend beyond the date at which the rating of (*4*) was reached.

(e) Other Tests. The (*State or City*) reserves the right to conduct whatever other tests are deemed necessary to determine the quality of the paints under consideration.

6. BIDS. All vendors whose samples receive a satisfactory rating will be given an invitation to bid. Each bidder will be required to file an affidavit that the material which he proposes to furnish will be identical with that of the sample submitted for performance tests or within the tolerances allowed. Materials will be evaluated by ranking them in descending order on the basis of a factor (Q) determined by the weighted rating (W), the total number of days each paint was rated as satisfactory (T), the estimated cost of application (C) and the total bid price, (P) and the contract will then be awarded to the responsible bidder whose material ranks highest. The formula which will be used for this purpose is as follows:

$$Q = \frac{WTF}{P + C}$$

In which

STATEMENT OF CHARACTERISTICS

(State or City) (Bureau of Purchases)

REFLECTORIZED PAVEMENT MARKING PAINT

For Confidential Use by (State or City)

To: The (*State or City*) Inquiry No. ____

_____

_____

The following are the characteristics of the designated sample of pavement marking paint submitted by the _____
(Company Name)

_____, of _____
(Address)

1. Manufacturer's Code No. _____
2. Color _____
3. Type (Premix, Drop-in) _____
4. Weight per Gallon ____ lbs. _____
5. Drying Time: (a) To touch _____ min. (b) Hard _____ min.
6. Viscosity _____ Krebs Units
7. Per Cent Pigment _____%
8. Pigment Volume Concentration _____
9. Per Cent Vehicle _____%
10. Per Cent Non-Volatile in Vehicle _____% State chemical nature of non-volatile vehicle: _____
11. Amount of Spheres per Gallon (Premix or combination type) _____ lbs.
12. Gradation of Spheres:

Premix or combination type		Drop-in or combination type	
U. S. Standard Sieve	% Passing	U. S. Standard Sieve	% Passing
No. 50	____%	No. 20	____%
No. 100	____%	No. 30	____%
No. 200	____%	No. 50	____%
		No. 100	____%
		No. 200	____%

13. Spheres not Round _____%.
14. Recommended Application Rate of Paint _____ gal./mile.
15. Recommended Application Rate of Beads _____ lb./gal.
16. For Yellow Paint Only:
    (a) Lbs. of Chrome Yellow per Gallon of Finished Paint ____
    (b) If no Chrome Yellow is used, what is substitute?_____ lbs./gal. ____
17. For White Paint Only:
    (a) Lbs. of TiO_2 per Gallon of Finished Paint ____ Type of TiO_2 _____
    (b) If no TiO_2 is used, what is substitute?_____lbs./gal.____
18. Recommended Solvent:
    (a) For Thinning _____
    (b) For Cleaning Marker _____

(Signed) _____

Name _____

Title _____

for the _____

_____

Mail to: *(State or City)*

_____

_____

W = Weighted rating
T = Number of days of the test during which the ratings (r) for all three qualities were above (*4*).
F = Average rate of application of the paint on the four test lines expressed as lineal feet of 4″ wide line per gallon
P = Bid price per gallon (in dollars)
C = Estimated application cost per gallon (in dollars)

NOTE 1. Each State or City can provide its own formula for evaluating the paints tested. The above is one possible formula.

NOTE 2. This method of ranking paints for purchase is valid only for the materials applied at the same time in a given test and should not be used to compare materials tested at different times.

7. PACKING AND MARKING. (a) Unless otherwise specified, paint purchased under this specification for regular use by the (*State or City*) shall be shipped in clean open-head steel drums of —gallons capacity, sealed vapor proof. Each container shall be plainly marked, both on the head and side, with a durable, weather-resistant ink or paint, showing the name and address of the manufacturer or vendor, description of material, purchase order number, batch number, and volume and weight of contents.

NOTE: The capacity of the paint containers desired by the State or City should be inserted in the blank space left. Pails or drums with a capacity of 5, 30, or 55 gallons are commonly used.

(b) The spheres for drop-in type paint shall be shipped in containers (bags, drums, etc.) holding (*50 or 60*) pounds of spheres. The containers shall meet Interstate Commerce Commission requirements, shall be strong enough to permit normal handling of the containers during shipment and transportation on the job without loss of spheres, and shall be sufficiently water resistant so that the spheres will not become wet or caked in transit.

8. SAMPLING AND TESTING. (a) Paint purchased under this specification will be sampled and tested by the (*State or City*) using the indicated standards and methods, including absorption spectroscopy, if desired, to determine conformance with specification requirements and to establish identity with

the sample originally submitted for performance tests. A sample shall consist of three pints taken from each production batch of (*500*) gallons or more. When sampled at the plant from vats, one-third of the sample shall represent the material coming from the vat at the beginning of the pour, one-third shall represent the material coming from the vat at the middle of the pour, and one-third shall represent the material coming from the vat at the end of the pour. If the paint is in containers, a three-pint sample shall be taken at random from a single container in each batch.

NOTE: If it is considered desirable to specify the minimum size of the production batch, this amount should be shown. Where large quantities are being purchased, a 500-gallon minimum size batch should not be considered unreasonable.

(b) The (*State or City*) reserves the right to inspect and accept the paint either at the destination or at the point of manufacture. In either case, the manufacturer shall furnish whatever samples and formulas are required to ascertain that the finished paint complies with specifications. If factory inspection is required, the inspector shall be afforded all necessary facilities to make the inspection, including one quart containers for shipment of samples to the (*State or City*). At the time when contracts are awarded, it will be decided, unless otherwise indicated when invitations to bid are extended, whether the paint is to be inspected at the factory or at destination. Any paint not meeting the specification shall be replaced with satisfactory paint, and all handling and transportation charges for such replacement shall be paid by the vendor.

9. ACCEPTANCE AND REJECTION. Paint furnished under the contract shall be identical with the sample submitted for performance tests or within the tolerances allowed and shall comply with the requirements herein set forth. In the event that the traffic paint does not comply with this specification or is not identical with the sample submitted or within the tolerances allowed, the vendor will be required to replace all such paint at his own expense, including all handling and transportation charges, with paint that does so comply.

Tolerances permitted between the paint delivered and the original sample submitted for service tests:

(a) *Weight per gallon.* Weight per gallon of all paint purchased on the basis of a service test for regular use by the (*State or City*) shall be within plus or minus (*0.25*) pounds of that or the original test sample.

(b) *Viscosity.* While the viscosity of the original test sample of paint may be anywhere within the range stipulated in this paragraph, the viscosity of all paint purchased on the basis of the performance test for regular use by the (*State or City*) shall be within plus or minus (*5*) Krebs units of that of the original test sample throughout the production of the entire order, with the further requirement that such range in viscosity be entirely within the above limits.

(c) *Color.* Slight differences in color between the paint delivered and the original sample will be permitted providing that the change does not detract from the appearance of the paint.

(d) *Vehicle.* The per cent of non-volatile material in the vehicle of the paint delivered shall not vary more than (*two*) per cent from the per cent of non-volatile material in the original sample submitted.

The Solution to Your Parking Problems . . . Automatically
Lower Cost—Higher Revenue

Before you consider any other method of controlling off-street parking—investigate Parcoa! Make a careful comparison between Parcoa equipment and other parking controls. Note, for example, the low initial cost of Parcoa and the high costs of meters . . . Analyze maintenance problems . . . 2 gates means 2 points of service . . . 1 collection point . . . 50 meters means 50 points of service and 50 points of collection.

Parcoa permits parking to continue day and night, *smoothly, safely, quickly,* without interruptions, confusion or overcrowding.

Here is an automatic system designed by skilled engineers for operating simplicity, low first cost, low operating cost . . . an investment that actually pays for itself. Parcoa offers 100% collection . . . ease of maintenance. Hundreds of satisfied customers in industry, hospitals, schools, business and municipalities have proved the dependability and efficiency of Parcoa equipment.

Investigate Parcoa—learn the many benefits and advantages . . . It may be the solution to your parking problems, too . . . Write today for Bulletin No. 580.

FLEXIBLE OPERATION
These control types give you a choice of individual or combination of controls to fit your needs.

CODED CARD-KEY
for cars parking on monthly or reserved basis.

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for controlled transient parking.

TICKET ISSUING SYSTEM
for merchants restricted free parking service.

TIME-DATED TICKET DISPENSER
for automatic self service in merchant participation parking.

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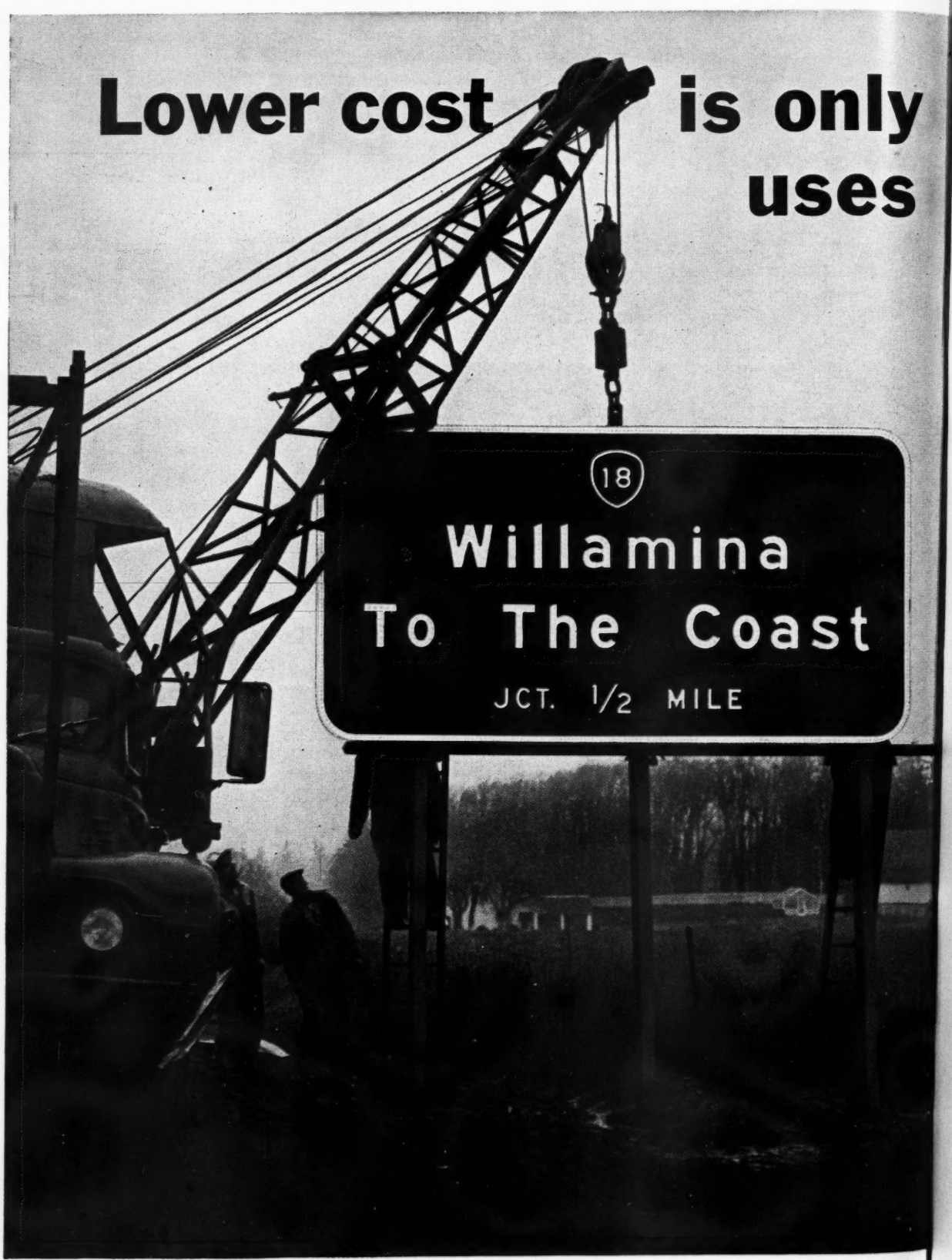
SALES AND SERVICE OFFICES IN OTHER MAJOR CITIES LISTED UNDER BOWSER, INC.



New colorfast green overlaid plywood with reflective button legend and border is used for green background direction signs.

one reason why Oregon signs of overlaid plywood

MODERN REFLECTORIZED OVERLAID PLYWOOD signs do a better job for the taxpayer as well as the motorist in Oregon.

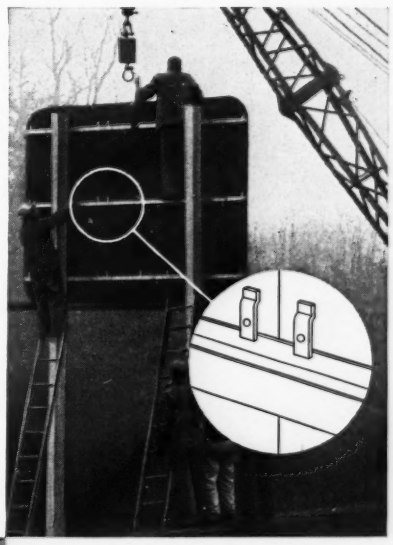
State highway officials estimate the overall cost of an overlaid plywood sign installation averages 20 percent less than other acceptable materials. Savings are based on lower basic material costs, faster fabrication and finishing (neither sign face nor back is painted; reflective legend is applied direct)—plus elimination of the need for special back framing on signs up to 40 square feet in area.

But lower cost is only part of the story. Basically, Oregon uses overlaid plywood because it makes a strong, good-looking sign that stands up under prolonged weathering and deliberate or accidental abuse.

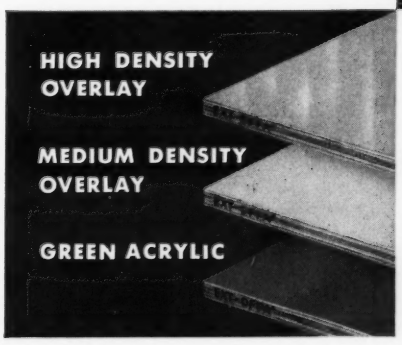
All told, the state maintains over 100,000 signs; 47,000 informational, 20,000 warning and 35,000 regulatory. Ninety percent are reflectorized, with reflective legend and border applied directly to the overlaid plywood surface. Key directional signs are illuminated. Black high density panels are used for warning and regulatory signs. New color-fast green acrylic overlaid plywood is used for green background direction signs to conform to national color coding on Interstate and other highways.

FOR MORE INFORMATION (detailed specifications, application data, etc.) write:
DOUGLAS FIR PLYWOOD ASSOCIATION
TACOMA 2, WASHINGTON
—an industry-wide organization devoted to research, promotion and quality control
Always specify by DFPA grade-trademarks

DFPA TESTED QUALITY



New panelized sign system used on recent Oregon installations employs standard aluminum girts and special clips. System is highly economical, permits flexibility in sign sizes and shapes. Developed by Douglas Fir Plywood Association, it meets all AASHO standards.



Medium density overlaid plywood is for plain painted signs; **high density** requires no paint protection and permits direct application of reflective sheeting. **New acrylic overlay** comes in green and white for signs with painted or reflectorized legend.

(e) The weight of the pigment in the paint delivered shall not vary more than (*two*) per cent from the weight of the pigment in the original sample.

(f) *Drying Time.* The drying time of the paint delivered shall not be less than (*sixty*) per cent or more than (*one hundred and twenty*) per cent of the drying time of the original sample submitted.

(g) *Spheres.* The amount of spheres per gallon of premix or combination types of paint, the gradation of spheres for any of the three types of paint, and the per cent of spheres not round shall not deviate from the characteristics of the test sample by more than (*ten*) per cent plus or minus for each characteristic.

COMMITTEE 7C
PAINT AND BEAD SPECIFICATIONS

Membership

Daniel A. Branigan (Chairman)
Illinois Division of Highways (Ret.)
Redondo Beach, California

William R. Carrow
Delaware State Highway Department
Dover, Delaware

Verle C. Crawley
Illinois Division of Highways
East St. Louis, Illinois

H. G. Eckhardt (deceased)
Ohio Department of Highways
Columbus, Ohio

Vince Greci
Clinton Company
Chicago, Illinois

T. L. Harrington
Minnesota Mining & Mfg. Co.
St. Paul, Minnesota

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W. J. Larkin
Cataphote Corporation
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Flex-O-Lite Corporation
St. Louis, Missouri

Dwight T. Myers
New York, New York

Lynn Stewart
Santa Barabara, California

Rex G. Still
Washington Highway Department
Olympia, Washington

Inquiry No. _____

CERTIFICATE OF COMPLIANCE
(*State or City*) (*Bureau of Purchases*)
Reflectorized Pavement Marking Paint

To: The (*State or City*)
_____
_____

Having Authority to act for the _____
(Company Name)

_____, of _____
(Address)

_____, I do hereby certify that the samples of reflectorized pavement marking paint designated as:

Mfgrs. Code Number	Color	Type

have been tested and have been found to comply with the requirements as to physical and chemical characteristics of the specification of the (*State or City*) under which the samples are being furnished.

(Signed) _____

Name _____

Title _____

For The _____

Of _____

Mail to: (*State or City*)
_____
_____

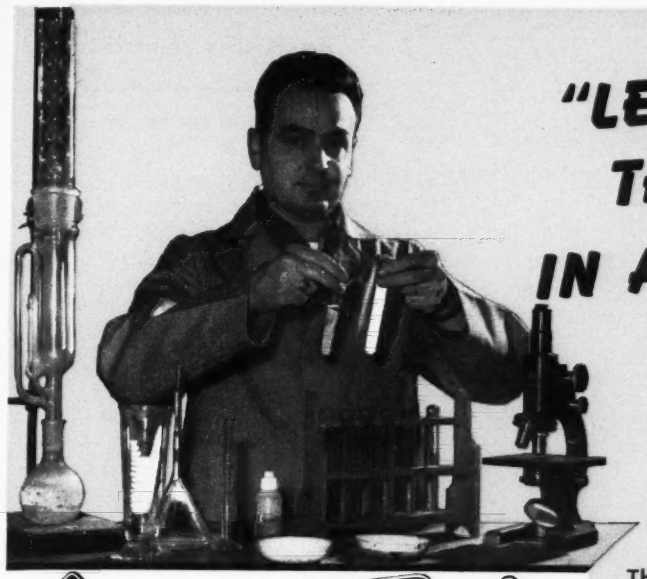
Date _____

ELECTRONIC COMPUTERS

(Continued from page 26)

the most efficient machine for the job should have magnetic tapes and have good reading and writing characteristics, preferably with input and output buffered so that reading, writing and computation can proceed at the same time.

There is another computer approach to the problem that has been employed by the State of California. All interzonal movements are read only one time and stored in the computer memory. The forecasting process then proceeds through as many approximations as desired, the interzonal movement table being modified in storage. At the conclusion, the forecasted movements are written out. This system is very efficient because the input and output is reduced to an absolute minimum. The disadvantage is that it is very extravagent in the use of storage, consequently, the number of zones that can be processed by a given size machine is severely limited. Remembering that the number of possible movements between zones is $\frac{n\ (n+1)}{2}$, it is apparent that the storage requirements increase as the square of the number of zones. If there is a large enough machine available to accommodate the



"LET ME SHOW YOU THE DIFFERENCE IN A TRULY WHITE, LEAD-FREE REFLECTIVE BEAD"

There is a marked difference in reflective bead quality, determined largely by degree of whiteness and lead-free quality. On these two important factors depends the brilliance, reflectivity and ultimate performance of the product. To meet Flex-O-Lite's rigid quality standards, only the *whitest white, lead-free* beads can pass inspection. Add to this, technological advances, long experience and manufacturing know-how and you have the reasons why highway signs and markers, reflectorized with Flex-O-Lite beads, literally leap out of the darkness to contribute greater safety for the motoring public . . . greater satisfaction and economy for you. Write for new brochure today.

FLEX-O-LITE PRODUCTS

1. No. 831 LEAD-FREE High Index of Refraction Beads and Sign Kits. Best for white and yellow signs.

2. UB 68 LEAD-FREE Medium Index of Refraction Beads and Sign Kits. For application to signs in the darker pigment colors—greens, reds, blues, etc.

3. TYPE H SAFETY SPHERES—For danger points such as guard rails, curbs, bridge abutments, medians, hydrants and other hazardous areas where ultra-high brilliance is required. Many times brighter than paint or ordinary reflectorization.

4. TRAFFIC BEADS—Free Flowing, Moisture-Proof and Standard Beads. Top in eye-catching brilliance and dependable reflectorization on highway center lines and edge line markings.

5. ALL-WEATHER AIRPORT RUNWAY BEADS—500 to 1,000% brighter than standard beads at angles of descent ranging from 10 to 30%.

6. FLEX-O-LITE ALSO MAKES: New Positive Free-Flowing Traffic and Sign Bead Dispensers. The economical answer to the problem of reflective glass bead application. Details on request.

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MAKERS OF DROP-ON, FREE-FLOWING, STANDARD, MILITARY, MOISTURE-PROOF, HIGH AND MEDIUM INDEX SIGN BEADS

largest zone system that the user will encounter, this system is the most efficient insofar as machine running time is concerned.

If the user is expecting to use an existing program to assign the forecasted volumes to a street system, it would be advisable to design the forecasting program in such a way that the final output may be used for direct entry into the assignment program without modification.

Because of recent program developments for the assignment of forecasted interzonal travel to street networks, several users have forecasted the interzonal trip volumes by direction rather than using trips between zones as described in the above discussion and shown in Table III and in Figure 2. To forecast by direction the input would be as shown in Table I with no modification of the programming logic.

The Fratar Method has been programmed by the Bureau of Public Roads for a large high-speed magnetic tape machine for 500 zones and three modes of travel. Experience has shown that a complete forecast can be obtained in about 2½ hours running time. This program is available for general use.

There is also available from the Bureau of Public Roads a manual of instructions for programming the Fratar Method for;

1. Conventional punched-card equipment and externally programmed electronic computers with limited storage.
2. Intermediate size electronic computers.
3. Large high-speed electronic computers.

GLOSSARY

ADDRESS—the number identifying the memory cell which contains some desired information. (In some computers certain registers, etc. also have addresses.)

CELL—the smallest division of the memory which is handled as a unit. In most computers a cell has storage capacity for one word. In some computers, however, a cell has capacity for one character (alphabetic or numeric). Each cell is identified by an address.

DATA PROCESSING—the manipulation of large quantities of input data, with the amount of computation resulting from each input usually being rather limited. (See also SCIENTIFIC COMPUTING.)

FILE—a large set of items stored either within the computer memory or on some external medium such as magnetic tape. During a data processing problem the computer may treat each item in the file in sequence or may select certain items from the file. The file is presumed to be arranged in some sequential order. Where the file is on an external medium, portions (or all) of the file may be called into the computer memory as required during the computation.

MEMORY—The portion of the computer which is used to store ("remember") instructions, data, and results. In some computers various levels of memory are available, the primary level being the "high-speed" memory. Where secondary lower speed memory units are provided, they are used as "back-up" storage containing information used less frequently or information used to file the "high-speed" memory.

PROGRAM—A plan for the solution of a problem. A complete program includes information as to the format of input data, the formulae for analysis, any special restrictions, the ROUTINE for instructing the computer, and the format for the results. (See ROUTINE.)

RECORD—a unit of information pertaining to the same item. The record may occupy one or more cells in the memory. (In a payroll processing program a record would be all of the information pertaining to one person.)

ROUTINE—a set of coded instructions which will cause the computer to proceed through the computation in a step-by-step manner.

SCIENTIFIC COMPUTING—the performing of computations involving rather complex mathematical relationships and requiring relatively little input data. Often a computation is to produce results for many regularly spaced values of some parameter; in such cases it is possible for the computer program to increment the parameter at the start of each run, eliminating the need for input data.

STORAGE—same as MEMORY.

WORD—a set of numbers or letters (or a combination) which occupies one memory cell. A word may be numeric data, an instruction, or special alphabetic information useful in the output (column heading, etc).

* * *

Duty: A task we look forward to with distaste, perform with reluctance, and brag about afterward.

* * *

No matter how high a man rises, he needs something to look up to.

* * *

You probably wouldn't worry quite so much about what other people think of you if you could know how seldom they really do.

FOR THE NEWEST BEST Most Accurate Aid To VEHICLE COUNTING

try Muni Quip's TRAFFIC COUNTER

- Counts cars, no chatter, accurate, counts every time.
- Counts cars immediately—No adjustment needed.
- Resets manually to zero.
- Counts 100,000 cars by direct reading.
- 12-volt operation—Uses two 6-volt batteries.
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Positions Available

DISTRICT OF COLUMBIA
Govt. Dept. of Highways & Traffic

TRAFFIC ENGINEERING DIVISION

Position: Supervisory Traffic Research Engineer Chief, Research Section.
Salary: $8810-$9530.
Requirements: BS degree in CE or EE with education and experience in traffic engineering. Would be responsible for conceiving and carrying to completion projects on existing and unique applications of traffic operational and control features, developing special equipment, and accident analysis.

Position: Highway Engineer.
Salary: $7510-$8230
Requirements: Degree, preferably in BSCE, with experience in highway layout, design and estimating.

Position: Traffic Engineer.
Salary: $6285-$6885
Requirements: BS degree, preferably in CE or EE, with experience in signal layout and coordination.

OFFICE OF
PLANNING AND PROGRAMMING

Position: Highway Research Engineer, Chief of Metropolitan Area Origin and Destination Survey Section.
Salary: $10,130-$11,090.
Requirements: BSCE degree or equivalent, with experience in conducting and analyzing origin and destination surveys.

Position: City and Highway Plans Analyst.
Salary: $7030-$8230.
Requirements: Degree with experience in city and highway planning.

Position: Highway Research Engineer, Chief of Planning and Research Section.
Salary: $10,130-$11,090.
Requirements: BSCE degree with experience in highway planning, research and economic investigations.

Position: General Engineer.
Salary: $7510-$8230
Requirements: Degree, preferably in CE with experience in planning highway systems and right-of-way engineering.

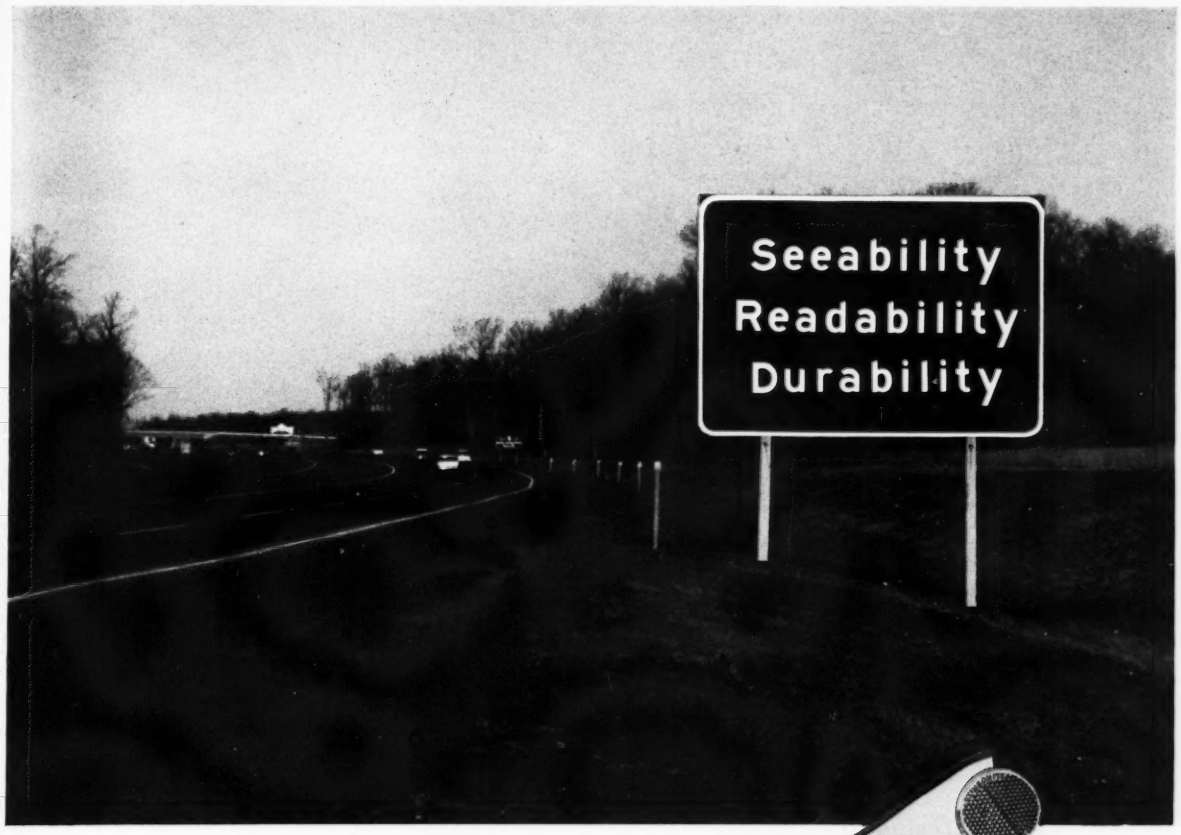
Benefits: Federal retirement, sick and vacation leave, and participation in insurance and health plans.

Apply: Personnel Officer, Department of Highways and Traffic, District of Columbia Government, 14th and E Streets, N. W. Washington, D.C.

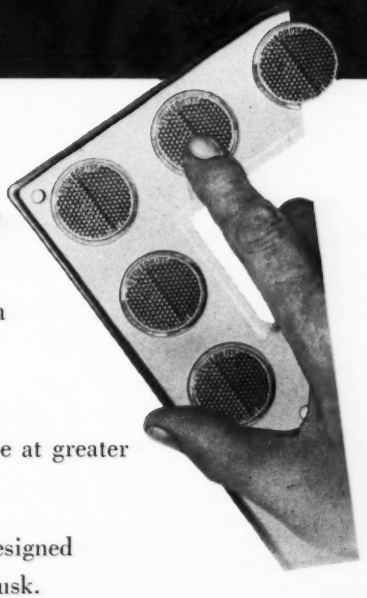
CITY OF PHOENIX, ARIZONA

Position: Traffic Engineering Supervisor.
Requirements: Professional traffic engineering and supervisory experience. In applying, please detail recent experience and chart your present organization, showing your position and number of employees supervised.
Salary: $500 to $630 per month; liberal fringe benefits.
Apply: Leroy J. Brenneman, Personnel Director, City Hall, Phoenix, Arizona.

(Continued on page 64)



STIMSONITE SIGNS THE WAY



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STIMSONITE is more readable! These bright letters are designed for the best legibility and clarity day, night, dawn or dusk.

And STIMSONITE is more durable! It will not fade or chip. Signs made with STIMSONITE letters, borders and symbols are permanent. They never need renewing or costly maintenance. For long term efficiency and economy, let STIMSONITE sign the way for you.

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MEMBERSHIP APPLICATIONS

The Institute of Traffic Engineers welcomes applications from qualified traffic engineers, but does not desire as members persons who are unqualified. Listed below are the names of those from whom applications for membership or transfer in grade have been received since the last published list. Institute members are urged to review this as soon as possible and immediately inform the Executive Secretary's office if names of people are found who are known to be unqualified for ITE membership or transfer.

New Applications

ANDAVAN, Gnanasundaram Marimuthu
Post Graduate Student in Highway & Traffic—University of Birmingham, Birmingham, England—for JUNIOR.

ANDERSON, Jack Webster
Traffic Design and Research Engineer—Minnesota Highway Department, St. Paul 1, Minnesota—for ASSOCIATE.

BEACH, Frank Chester
Assistant Planning Engineer—Wayne County Road Commission, City-County Building, Detroit 26, Michigan—for ASSOCIATE.

CHRIST, John Earle
Senior Traffic Engineer—Bureau of Traffic Safety, State House, Trenton 25, New Jersey—for JUNIOR.

DALTON, Thomas Joseph, Jr.
Traffic Engineer—St. Louis County Division of Traffic, Room 202, 115 N. Meramec, Clayton 5, Missouri—for JUNIOR.

DISHER, Jerrold Ward
Highways Engineer—C. C. Parker & Associates, Ltd., 795 Main Street West, Hamilton, Ontario, Canada—for ASSOCIATE.

HURLEY, John Francis
Assistant Traffic Safety & Operations Engineer—Massachusetts Department of Public Works, 100 Nashua Street, Boston, Mass.—for ASSOCIATE.

ORRISON, William Wallace
Supervisory Traffic Engineer—Headquarters Air Training Command, USAF, Deputy Chief of Staff/Civil Engineering, Hq ATC, Randolph AFB, Texas—for ASSOCIATE.

PALMATEER, James Clayton
Traffic Engineer in charge of Operations—King County Engineer, 905 County-City Building, Seattle 4, Washington—for ASSOCIATE.

RAINVILLE, Walter Stewart, Jr.
Director of Research—American Transit Association, 355 Lexington Avenue, New York 17, New York—for MEMBER.

RICE, Sheldon
Traffic Engineer—Wilbur Smith & Associates, 580 Market Street, San Francisco, California—for JUNIOR.

SIFRER, Albert
Assistant District Engineer of Design, State of Illinois Division of Highways, 160 LaSalle Street, Chicago 1, Illinois—for ASSOCIATE.

SMITH, Sanford Hale
Traffic Control Supervisor—City of Greensboro, Drawer W-2, Traffic Engineering, Greensboro, North Carolina—for JUNIOR.

Applications for Transfer

BARTELS, William Joseph
Traffic Planning Engineer—City of White Plains, New York—for ASSOCIATE.

COX, Robert Lou
Associate Engineer—Wilbur Smith & Associates, 495 Orange Street, New Haven, Connecticut—for ASSOCIATE.

IVEY, Joseph Bennett
Traffic Operations Engineer—City of Richmond, Virginia—for ASSOCIATE.

LEWIS, Brian John
Partner—Whipple, Murphy, Pearson & Associates, Construction Engineers, 403 Alaska Trade Building, Seattle 1, Washington—for ASSOCIATE.

MANCINI, Rocco A.
Traffic Engineer—Edwards & Kelcey, Inc., 470 Atlantic Avenue, Boston 10, Mass.—for ASSOCIATE.

McCURDY, Bill LeRoy
Assistant Traffic Engineer—Oklahoma Department of Highways, Oklahoma City, Oklahoma—for ASSOCIATE.

STEVENS, Dudley Field
City Traffic Engineer & Parking Director, Sacramento, California—for MEMBER.

WEGEL, Charles Arthur
Traffic Commissioner—City, Room 301 Municipal Building, Hamilton, Ohio—for ASSOCIATE.

Yearbook Changes

BATES Russell G. (Associate)
4654 No. Harrison Avenue, Fresno, California.

BERMAN, Jack (Junior)
Assistant Highway Planning Engineer, Port of New York Authority, 111 8th Avenue, New York 11, New York. ALgonquin 5-1000.

BREUNING, Siegfried M. (Associate)
Associate Professor of Civil Engineering, Michigan State University, Highway Traffic Safety Center, East Lansing, Michigan. EDgewood 2-1511, ext. 2855.

CAL y MAYOR, Rafael (Associate)
Director General, Centro de Adiestramiento de Operadores, 546 Av. F. C. de Cuernavaca, Mexico 20, Distrito Federal, Mexico. 14-80-33.

CARMODY, Douglas J. (Associate)
Director of Parking & Traffic, City, P. O. Box 642, Modesto, California. LAmbert 4-4011.

FERRO, William N. (Associate)
Chief Traffic Engineer, Metropolitan Planning Commission, P. O. Box 1646, Knoxville, Tennessee. 4-8618.

FLETCHER, Scott (Junior)
Traffic Engineer I, City Bureau of Traffic Engineering, Department of Streets, Room 1002 City Hall Annex, Philadelphia, Pennsylvania. MUnicipal 6-9700. SEND MAIL: 1966 Hansell Drive, Cornwells Heights, Pennsylvania.

GRANZOW, Edward F. (Associate)
Traffic Engineer, City, 204 East Center Street, Anaheim, California. KEystone 3-1321.

HATHAWAY, Cecil W. (Junior)
Assistant Traffic Engineer, Idaho Department of Highways, 155 South Eighth Street, Boise, Idaho. 4-5811, ext. 263. SEND MAIL: 1004 Lander, Boise, Idaho.

JOHNSTON, J. Edward (Member)
Assistant Director of Highways in charge of Planning, Utah State Department of Highways, 422 Capitol Building, Salt Lake City 14, Utah.

KARMEIER, Delbert F. (Junior)
Traffic Engineer, St. Louis County Division of Traffic, 115 North Meramec, Clayton 5, Missouri. PArkview 1-8355.

KARNIG, Barkev (Associate)
Acting Traffic Signal Engineer, Ontario Department of Highways, 559 Jarvis Street, Toronto, Ontario, Canada. CHerry 4-2571. SEND MAIL: 235 Hanna Road, Toronto 17, Ontario, Canada.

MANNING, John (Junior)
Director of Traffic & City Planning, Room 1 City Hall, Schenectady, New York. FRanklin 4-4121. SEND MAIL: 1590 Wendell Avenue, Schenectady, New York.

MARSTON, William R. (Member)
City Traffic Engineer, Bureau of Street Traffic, Room 709 City Hall, Chicago, Illinois. RAndolph 6-8000. SEND MAIL: 860 Lake Shore Drive, Chicago 11, Illinois.

NINTZEL, Hans W. (Junior)
Programmer—Digital Computers, Computer Usage Co., 18 E. 41 Street, New York, New York. SEND MAIL: 852 East 19th Street, Brooklyn 30, New York.

ROBERTSON, James B. (Junior)
Traffic Engineer, City Hall, San Leandro, California. NEptune 8-4100, ext. 336.

SCHMIDT, James W. (Junior)
Assistant Manager, Salt Lake Transportation Study, Utah State Road Commission, 525 West 1300 South Salt Lake City, Utah. SEND MAIL: 1556 Westminster Ave., Salt Lake City, Utah.

SCHROEDER, Robert L. (Junior)
Sign Design Engineer, Traffic Engineering Division, Oregon State Highway Department, State Highway Building, Salem, Oregon. EMpire 4-2171, ext. 1261. SEND MAIL: 4390 Lone Oak Road, S. E., Salem, Oregon.

SHERIDAN, Robert E., Jr. (Junior)
Traffic Engineer I, Room 411 City Hall, North 221 Wall Street, Spokane 1, Washington. MAdison 4-4341, ext. 270. SEND MAIL: P. O. Box 1369, Spokane, Washington.

SIVER, Richard W. (Associate)
Consultng Traffic Engineer, Traffic & Street Sign Company, 84 Foundry Street, Newark, New Jersey. MArket 3-6640. SEND MAIL: 60 Virginia Avenue, Manasquan, New Jersey.

WITHEFORD, David K. (Associate)
Assistant Study Director, Pittsburgh Area Transportation Study, 14 Wood Street, Pittsburgh 22, Pennsylvania. EXpress 1-3850.

VOLUME AND TIMING STUDIES

(Continued from page 18)

Acknowledgment

The author wishes to express his sincere appreciation and thanks to Mr. J. L. Clarke, City Signals Engineer, and Mr. W. D. Finnbogason, Traffic Engineer, for their aid and understanding during the course of the study, and also Mr. L. R. Campbell (Electrical Engineer), Traffic Engineering Department, for his cooperation, technical advice, and for the correction of the grammatical errors caused by the unfamiliarity, on the author's part, of the English language.

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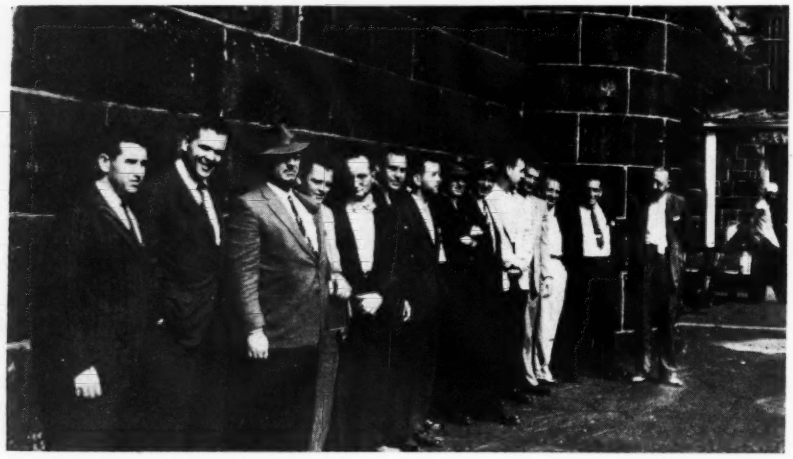
Section News



WASHINGTON (D.C.) SECTION

Grim-faced in this line-up at Maryland State Penitentiary are members of a Metropolitan Washington D. C. Traffic Engineering Subcommittee who visited the institution to learn about its traffic sign making shop. Under the direction of the Metropolitan Area Traffic Council, the Subcommittee's aim is more widespread traffic control uniformity in the 2,300 square mile metropolitan area. Sole fugitive from the group is Chairman Kenneth W. Smith.

WESTERN SECTION

TENTATIVE PROGRAM — 13TH ANNUAL MEETING
WESTERN SECTION — INSTITUTE OF TRAFFIC ENGINEERS
SAN FRANCISCO — JULY 17-20, 1960 — JACK TAR HOTEL

SUNDAY, July 17
- 1:00-5:00—Registration
- 2:00- —Meetings of the Western Section Committees
- 5:00-7:00—RIBBON CUTTING
- Evening—Conversation Time (Opportunity to meet with colleagues, suppliers, etc.)

MONDAY, July 18
- 9:00—Registration Continues
- 9:30—Opening Session
- 10:30—TECHNICAL SESSION #1
  - A. Professional Status—Should We Be Traffic or Transportation Engineers?
  - B. Function of Highway Transportation in the Community.
- 12:30—Kickoff Luncheon
- 2:00—Western Section Annual Business Meeting (Part 1)

TUESDAY, July 19
- 9:00—TECHNICAL SESSION #2—Traffic Operations
  - A. Speed Zoning — Selective or Blanket? (Panel Discussion)
  - B. Control of Traffic for Special Events
    1. Colosseum (Los Angeles)
    2. Candlestick Park (San Francisco)
    3. Exposition 21 (Seattle)
  - C. Freeway Traffic Operations
  - D. Effect of Subdivision and Shopping Center Design on Traffic Operations.
- 12:30—Western States Luncheon
- 2:00—TECHNICAL SESSION #3—Transportation in the C.B.D.
  - A. Parking Garages—Design Criteria
  - B. Truck Operations in the C.B.D.
  - C. Pedestrian Malls

WEDNESDAY, July 20
- 9:00—Western Section Annual Business Meeting (Part 2)
- 10:30—TECHNICAL SESSION #4—Mass Transit
  - A. Current Status
  - B. Potential Rail Solutions
  - C. Potential Bus Solutions
  - D. Warrants for Exclusive Bus Lanes
- 2:00—TECHNICAL SESSION #5—Traffic Engineering Research
  - A. A Theory for Traffic Flow on Urban Streets
  - B. Vehicle Operating Characteristics Affecting Highway Planning & Design.
  - C. The Driver Simulator — A Progress Report
- 3:00—WHAT'S NEW IN THE WEST?
- 7:00—Reception
- 8:00—ANNUAL BANQUET

SOUTHERN SECTION

The annual meeting of the Southern Section was held March 7 in Jacksonville, Florida during the Southern Safety Conference.

New officers for 1960-61 were announced following a tally of mail ballots received:

Herman J. Hoose ..... *President*
Marble J. Hensley ..... *Vice President*
John F. Exnicios ..... *Secretary-Treasurer*

A report was presented on the balloting to authorize the Florida group to withdraw to form a new Section. The tally showed 25 votes cast, with 14 against and 11 for the withdrawal. After discussion, the group agreed unanimously to present a joint letter from the Southern Section and the Florida group to the Institute Board of Direction, outlining the facts and requesting advice on future procedure. Ed Mueller made the point that the Florida group had not attempted to bypass the Section.

The next annual meeting of the Section was announced for Atlanta in March 1961, with a program committee of C. A. Rose, W. S. Derrick and Karl A. Bevins.

A resolution presented by Basil Andrews was adopted, urging the Southern Safety Congress to consider a resolution calling upon Southern Governors to hold an annual statewide safety conference.

FLORIDA SECTION (Proposed)

Jacksonville Conference—A Recap

We were very glad to see such a good delegation of Florida traffic people at the Southern Safety Conference. This representation proved to be important in further establishing and identifying the Florida Section. There were over 30 delegates from our Newsletter mailing list, and the list got a little longer while we were there.

Lamar Thomas is to be commended for his technical program arrangements, and the tours arranged by Henry Boggs were enjoyable (in spite of the cold weather) and informative.

A number of Florida delegates attended the business meeting of the Southern Section, ITE, which followed an excellent luncheon attended jointly by the Florida and Southern Sections. At this meeting Ed Mueller announced the progress of the Florida Section, and assured the Southern Section that our actions to form a separate section have been in good faith and to the advantage of the Institute. Remarking on an incomplete poll of Southern Section members on the issue of the "secession" of Florida, Mr. Robert Burch, Secretary-Treasurer of the Institute representing the Southeast District, advised that in his opinion much of the adverse sentiment among Southern Section members resulted from lack of proper communication between the two sections. It was voted that Mr. Ed Mueller, President of the Florida Section, should be invited to prepare jointly with Mr. Herman Hoose, newly elected President of the Southern Section, a letter to the ITE Board of Direction expressing the attitudes of the two Sections.

The Florida group later decided to express its intentions and its feelings in the matter in an open letter to the Southern Section. The letter follows:

Gentlemen:

Inasmuch as we are given to understand that, before making a final approval of the Florida Section, the Board of Direction of the Institute of Traffic Engineers wishes to have the Florida members clear with the Southern Section, we submit herewith all pertinent information as previously discussed in your September and March business meetings.

Since early in 1956 there has been con-

siderable discussion among Florida members on the subject of forming a sub-section or separate section. The principal reasons for this feeling may be summarized as follows:

1. *Geography.* Because of the geographic size and shape of the State of Florida and its peninsular situation with respect to the other southern states, the amount of travel required to reach Southern Section meetings has discouraged participation in Section affairs.

2. There exists now among Florida members a substantial and increasing interest in professional and Institute affairs. This is not reflected in Southern Section activities largely because of the geographic difficulties mentioned above.

3. The number of Florida members of the Institute has now increased to 29. In addition there are a number of engineers, who are qualified or will soon qualify for ITE membership, who should be actively encouraged to join.

In early 1959, a poll of Florida members showed a strong interest in the immediate formation of either a sub-section or section. On July 10, 1959 a meeting of some 15 members showed a unanimous opinion that ultimately a separate section should be formed. A close majority favored immediate formation of a section rather than sub-section. Those who felt it should be the latter have since given their full support to the section formation.

In what was felt to be strict accordance with the procedures for such action as set forth in the Institute By-Laws, a petition containing 23 signatures of Florida members was submitted to the Board of Direction requesting the authority to form a Florida Section. The Florida members were advised that this authority was granted at the September Board Meeting, and that the official approval of the section would be commensurate with the approval of the section constitution and by-laws after adoption by the Florida membership. This was announced by the Florida members and discussed at length at the September meeting of the Southern Section in New York.

Again, strictly following designated procedures, the Florida Section Constitution and By-Laws were adopted unanimously by a vote of 20 Florida members. This was submitted to the Institute Board of Direction for its approval. Following the January meeting of the board, we were advised of the opinion of the board that the Florida members should further clear with the Southern Section.

We very much regret that certain Southern Section members have felt the Florida members by-passed the Section in taking this action. There is certainly no intent to do so. All action taken was what we truly felt to be strictly in accordance with the Institute by-laws and open and sincere in purpose. If the action has not been discussed with the Southern Section membership to a satisfactory extent, then we most sincerely apologize.

As you know, the Florida Section, unofficial as it may be, has been operating to immense advantage. Open quarterly business meetings have been held in October, December and March, and plans are made for the next meeting in June, and for sponsoring of a traffic engineering short course in the fall. The Board of Directors has met each month. A monthly Florida Section Newsletter has been published since October and has a mailing list of over 100 names. Attendance at meetings has never been less than 25, papers are being prepared, and interest is at a high pitch. We feel that we have become a real asset to the Institute.

As Florida members of the Institute, and in accordance with the wishes of the Board of Direction, we wish, therefore, to concur and endorse the proposal that the President of the Southern Section and the President of the yet unofficial Florida Section jointly prepare a letter to the Board of Direction expressing in full the attitudes of the membership in the Southern Section and Florida.

Respectfully submitted,
FLORIDA MEMBERS OF ITE
/s/Edward A. Mueller, *President*

INDIANA, MICHIGAN, OHIO SECTIONS and ONTARIO MEMBERS

The annual outing of District 3 members is scheduled for Cedar Point, Ohio, on June 10-12. Plan to attend now.

NEW ENGLAND SECTION

Sub-section meetings in the Massachusetts and Connecticut areas were held during the unpredictable months of January and February and proved very successful. The combined attendance at both meetings in general exceeded that which would be normally expected at a single combined meeting. Furthermore, it offered an opportunity for those in the separate areas to develop technical programs suited to their particular desires.

March Meeting

Although the official March meeting of the New England Section, Institute of Traffic Engineers, did not start until 6:00 p.m. on March 21 in Boston, for all practical purposes, it started shortly after noon when Matt Huber, as Chairman, banged the gavel

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opening up the Traffic Engineering Meeting of the two day Massachusetts 39th Annual Safety Conference which was then in session at the Hotel Statler in Boston.

This session entitled "Solving Metropolitan Transportation Problems Through Traffic Engineering" consisted of three excellent presentations. William W. Nash, Instructor in City Planning, Graduate School of Design, Harvard University, spoke on "Economic and Social Impact of Highways" followed by Robert G. Davidson, Transportation Associate, Seminar Research Bureau, Boston College, who spoke on "Transportation Planning in Greater Boston with Gravity Models." Both of these presentations were based on factual data on local problems and proved very interesting.

The anchor man at this session was our own national President, Ed Wetzel, who spoke on "Traffic Planning for Freeway Operations." Ed's long experience in and around New York City with expressways and super highways certainly qualified him to report on problems we now have in the New England Area.

This particular session was very well attended with about 75 present. Bruce Campbell who, in case you do not realize it, is one of our own members and Executive Vice President of the Massachusetts Safety Council, personally organized this session.

After this Safety Council Session was concluded, the Section officers, committee members and all other members interested met at the nearby Club 57 for a joint committee meeting relative to the proposed By-Law Changes and to discuss the suggested Section report on the Highland Park Workshop Conference.

The official meeting of the New England Section started at 6:30 p.m. at the Club 57 with an excellent full course chicken dinner with 42 members and guests present.

The business meeting started with an introduction of all present followed by an excellent report by Bill McGrath, Chairman of the Workshop Committee. This report was an excellent analysis of the recommendations of the workshop proceedings and it is difficult to visualize any radical changes when it is discussed by the full membership at the next meeting for adoption and submission to the Institute.

Speaker of the evening was ITE President Ed Wetzel who spoke on "Traffic Engineering — A Dynamic Profession." Ed's rather informal talk on the activities of the Institute, the Freeway Seminars, and the duties and responsibilities of the Institute of Traffic Engineers was an inspiration to all. His point that traffic engineering is a dynamic profession and will take a greater part in the future is well realized by those who have seen the importance of traffic engineering grow during the past 30 years. During the following question period, Matt Huber asked "What can the individual Sections do to help the growth of Traffic Engineering as a profession?" To this Ed quickly answered—"Take a more active part in the activities of the Institute." That is a very good answer to what might appear to be a complex question and could well be a model for us as individuals as well as Sections.

MISSOURI VALLEY SECTION

MOVITE In May

Two significant events for MOVITE members are planned for May. The annual Missouri Highway Conference in Columbia, Missouri, May 11 and 12, 1960 will have as a joint sponsor the ITE Freeway Operations Committee and will be preceded by the spring ITE Board of Direction meeting. The MOVITE annual meeting has traditionally been held in conjunction with this Highway Conference.

The success of the series of ITE Freeway Operations seminars led to the proposal for the Institute to continue to take a leading role in sponsoring jointly with others, similar seminars or conferences. A standing committee, the Freeway Operations Committee, has been established to sponsor or co-sponsor and to assist in the planning of seminars or conferences in which a part of the program of such meetings is devoted to traffic operations in all of its aspects. This committee has already been active, assisting in the planning of a conference held at Michigan State University and the one to be held at the University of Missouri in May. The Institute is co-sponsoring the Michigan conference and will participate as a joint sponsor in the conference at the University of Missouri.

MOVITE AREA ITEMS

Iowa

Sioux City has finished a check up on the one-way streets after the installation of the first one-way pair. After 90 days, the accident rate was 9.4% below a year ago in spite of the more severe winter this year, and travel times have been decreased by 17% on one of the streets and 8% on the other.

Kansas

The Traffic and Safety Department of the Kansas Highway Commission has two research projects underway that might be of interest to others.

Our Highway Patrol and others have, for several years, requested that a "NO PASSING ZONE" sign be erected on the left hand side of the roadway facing traffic approaching the zone, to supplement the existing "DO NOT PASS" sign erected on the right hand side of the roadway and the yellow no-passing pavement marking. A 75-mile section of US 54 west of Wichita has been selected as the test section of two-lane highway to be signed for this study.

The Kansas Highway Commission, in conjunction with the Bureau of Public Roads, is conducting a study of pavement edge marking of rural highways. A total of 384 miles of pavement with edge marking is in place in Kansas of which 193 miles is a part of this study. There are 191 miles of rural highway with no edge marking being used as a control section for this study. The marked and unmarked test sections are similar in characteristics and are distributed throughout the entire state.

Missouri

The department is currently enjoying an era of excellent cooperation from all public information media. Numerous news items in the press and on radio and TV; plus TV appearances already made and scheduled for the future for staff members has made many Kansas Citians more aware of the impact the Traffic Department has on the level of traffic movements in the city. City Traffic Engineers, Roger Kuehl and John Hartley recommended planned public information programs to all MOVITES. They feel it's paying off in Kansas City.

METROPOLITAN (N.Y.) SECTION

News Items

Ken Crowley has been promoted from Assistant Highway Planning Engineer in the Port Development Department of the Port of New York Authority to the position of Research Analyst in the P.A.'s Tunnels and Bridges Department.

Hans Nintzell, Assistant Civil Engineer of the New York Department of Traffic is now with Computer Usage Company working with Electronic Digital Computers.

The new address of the Essex County Traffic Division is 900 Bloomfield Avenue, Verona, N. J.

It is a brand new, air-conditioned building and Clarence Rusby offers to show any Section members who may be interested around the new quarters.

Patrick J. O'Leary has been elected President of the Municipal Engineers Society of New York City. He is the first traffic engineer to head the organization.

Henry C. Gilewicz, formerly with the New York City Department of Traffic, is now attending Columbia University full time for his M.S. degree in Industrial Management.

Wes Bellis reports that he is recovering rapidly, and is back at work after an absence of 2½ months.

Ernie Geissler has left us to take a position as County Engineer in the State of Washington.

In a complex interchange of personnel between the Highway Planning section and the Traffic Engineering Division of the Port Authority, Ed Cantilli left the Highway section to take a newly created position of Traffic Engineer II in the division of the same name; Lee Goodman left Traffic Engineering Division to fill the position of Highway Project Planner thereby vacated in the Highway section; and Vito Soranno moved from the Highway section to fill Lee's shoes as Traffic Engineer I.

Colonel Bender and Warren Quimby are still wondering: Who's on first?

First Section of Second Deck of George Washington Bridge in Place

A unique construction operation began at 10 a.m. Monday, January 18, as the first of 76 massive structural steel sections for the second deck of the George Washington Bridge was hoisted into a temporary resting place behind the New York tower. The new six-lane level is under construction by The Port of New York Authority to increase the capacity of the world famous bridge and expedite the flow of traffic between New York and New Jersey. Together with its approaches, the bridge improvement will cost $183,000,000.

The hoisting was accomplished by strong lifting cables suspended from four self-powered trolleys running on tracks under the existing span.

The section was moved eastward along the trolley tracks to its permanent position over the southbound lanes of the Henry Hudson Parkway beginning at 1 a.m. the following morning—an hour chosen because this operation did involve re-routing traffic on the highway below. The huge (220-ton) assembly, which consisted of a complete lower deck cross section of girders, floor beams, trusses and diagonal members, was then fastened to steel connecting plates provided in the original bridge structure. The section's various pieces had been put together in advance of moving day in the contractor's yard adjacent to the New York tower.

Like the nine sections which will eventually be fitted into place along the New York over-land portion of bridge, the eight Jersey shore sections will be rolled into place via the trolley tracks. Sections destined for over-water expanses will be assembled on barges which will then be anchored in the river directly under the spot where they will be joined to the bridge.

This part of the second deck construction (which calls for 13,875 tons of steel in all) is scheduled to be completed by early 1961. The entire lower level project, including expanded approaches in New York and New Jersey, is still scheduled for completion in 1962.

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CANADIAN SECTION

Manual on
Uniform Traffic Control Devices for Canada

This eagerly-awaited Manual has just been published by the Canadian Good Roads Association, and the Canadian Section can take great pride in the very important role it had in its preparation. Members from coast to coast gave freely of their time and energy and the finished product speaks highly for their efforts. The manual is clear, comprehensive and well-illustrated, and should be in the possession of every agency in the country concerned with Traffic Safety and Operations.

The manual is distributed by the Canadian Good Roads Association, 270 MacLaren Street, Ottawa 4, Ontario, at $3.75 a copy. Leatherette binders at $2.50 each are optional.

Annual O.T.C. Traffic Training Course

The Ontario Traffic Conference announces that the Annual Traffic Training Course will be held at the University of Western Ontario, London, Ontario, from May 29th to June 10th.

The course is divided into two distinct parts to satisfy the needs of: 1. Traffic Police, 2. Traffic Engineering Personnel.

The Course Director is Professor Edwards, M.S.C.E., and other members of the Canadian Section on the course committee are: Eric Wiley, Chairman, Grant Bacchus and Inspector Crosbie.

Further information can be obtained from Mr. R. F. Anderson, Secretary-Treasurer, O.T.C., 2001 Eglinton Avenue East, Scarborough, Ont.

POSITIONS AVAILABLE

(Continued from page 56)

WYOMING HIGHWAY DEPT.

Position: Engineer for Cheyenne headquarters office, to work with both design and operations problems, with small but growing traffic division. Some travel—all expenses paid.
Requirements: Graduate CE, with additional traffic training desirable.
Salary: From $450 to $620, depending upon experience.
Apply: Thomas E. Kilty, Personnel Director, Wyoming Highway Dept., Cheyenne, Wyoming.

CITY OF EVANSVILLE, INDIANA

Position: City Traffic Engineer, to head revitalized traffic program.
Requirements: Registered professional engineer, over 25 years of age, with at least two years of active practice in traffic engineering; ability to supervise and plan traffic engineering program in city of 140,000.
Salary: $10,000 annually to start, with an ultimate of $12,000.
Apply: Mr. Harry Thompson, Screening Committee, c/o Old National Bank, Evansville, Indiana.

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Prismo reflective marking materials have consistently outperformed and outlasted all others in the most rigid, comprehensive road tests. Transverse Prismo lines were subjected to gruelling abuse . . . intense wheel abrasions and severe weather-wear failed to diminish their rain-or-shine efficiency and 24-hour visibility. These tests, supervised by traffic engineers and completely unbiased, are unchallenged testimony that NOTHING EQUALS PRISMO *BUT* PRISMO, the acknowledged world-leader in the field of reflective traffic marking.

PRISMO
SAFETY CORPORATION
Huntingdon, Pennsylvania